SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JANUARY 1907.

GENERAL PHYSICS.

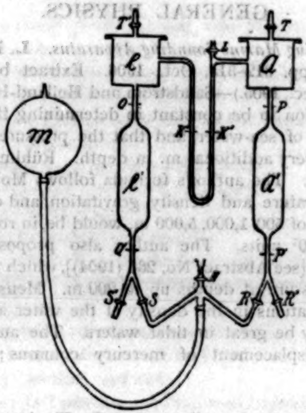
1. *Modified Mensing Marine Sounding Apparatus.* **L. Marini.** (Zeitschr. Instrumentenk. 26. pp. 812–815, Oct., 1906. Extract by H. Maurer from Rivista Marittima, Dec., 1905.)—Sandström and Helland-Hansen had assumed density and gravitation to be constant in determining the relation between depth and pressure of sea-water, and that the pressure would increase by 10^5 c.g.s. units for every additional m. in depth. Rühlmann and Mohn have given other formulæ. The author's formula follows Mohn's, and allows for variations of temperature and density, gravitation, and compressibility; his pressures for depths of 500, 1,000, 5,000 m. would be, in round numbers, 504·3, 1,009·9, 5,097·3 in 10^5 units. The author also proposes modifications of Mensing's apparatus [see Abstract No. 266 (1904)], which records by electrical means the water pressure at depths up to 200 m. Mensing's records would be influenced by variations in the density of the water above the apparatus, which variations may be great in tidal waters. The author's mechanism is based upon the displacement of mercury columns; Maurer suggests improvements. H. B.

2. *New Manometer for Low Pressures.* **E. Hering.** (Ann. d. Physik, 21. 2. pp. 319–341, Nov. 8, 1906. Extract from an Inaugural Dissertation.)—This is an examination of the working of a modified form of manometer due to Paschen (for details of which the paper must be referred to) and its comparison with a McLeod manometer. It is concluded that pressures down to 0·001 mm. of mercury can be measured with the new manometer, while with care McLeod's will give pressures down to below 0·05 mm. R. E. B.

3. *Collapsing Pressures of Bessemer Steel Lap-welded Tubes.* **R. T. Stewart.** (Amer. Soc. Mech. Engin., Trans. 27. pp. 780–820; Discussion, pp. 820–822, 1906. Read May, 1906. Mech. Eng. 17. pp. 795–798, June 9, 1906. Abstract.)—The paper includes description and drawings of the apparatus used for the tests, which were made at the National Tube Co.'s works upon several hundreds of commercial tubes. It was found that the length of tubes when greater than 6 diameters does not appreciably affect the strength. The following formulæ are deduced for tubes longer than 6 diameters. For values of P less than 581 lbs. per sq. in. or of t/d less than 0·023,

$P = 1000(1 - \sqrt{1 - 1600t^2/d^2})$; for higher values, $P = 86670\, t/d - 1386$; where P = collapsing pressure in lbs. per sq. in., d = outside diam. of tube in inches, and t = thickness of wall in inches. These were tested for sizes from 8 to 10 in. outside diam. in all obtainable commercial thicknesses of wall, and tables and charts founded on the formulæ are added. The factor of safety recommended is from 3 to 6, according to conditions of use. Collapsing stresses varied from about 7,000 lbs. per sq. in. for the relatively thinnest, to 35,000 lbs. per sq. in. for the relatively thickest walls. The average yield-point of the material was 37,000 lbs. and tensile strength 58,000 lbs. per sq. in. F. R.

4. *New Volumenometer.* **A. Lo Surdo.** (N. Cimento, 12. pp. 41–47, July and Aug., 1906.)—The apparatus consists of two cups, *a* and *e*, communicating with two vessels, *a′* and *e′*, of about equal volumes to *a* and *e* respectively, these being connected through the taps R, S, and N to the mercury reservoir *m*. A U-tube, which acts as a manometer, is also inserted between *a* and *e*, and the connecting tubes between the vessels are marked at P, Q, P′ and Q′. Then if volume a = volume $a' = V$ and volume e = volume $e' = V'$, and a' and e' are initially filled with mercury up to P and Q, the air being under atmospheric pressure H and the level of the liquid in the manometer being equal at K K′, on lowering *m* until the mercury falls to P′, Q′, the pressure on the air in the vessels will be reduced to H/2. Returning to the initial condition and introducing into *a* a body of volume X, the volume of air in *a* will be $V - X$, and on lowering *m* until the mercury reaches Q′, still keeping the manometer liquid at K K′, a quantity of mercury will remain in *a′* above the mark P′ equal in volume to that of the body introduced into *a*, which may be either measured by having the tube above P′ graduated, or, more accurately, weighed. Any slight differences in volume between *a*, *a′*, and *e e′* may be readily ascertained by carrying out a preliminary experiment with a body of known volume in *a*, and these can then be eliminated by introducing bodies of the required volumes to render $a = a'$ and $e = e'$. With an apparatus in which V = about 55 c.cm. it is possible to determine volumes up to about 45 c.cm. with an approximation of $\frac{1}{1000}$. W. H. Sl.



5. *Hardness of Constituents of Iron and Steel.* **H. C. Boynton.** (Iron and Steel Inst., Journ. 70. pp. 287–318, 1906. Carnegie Scholar's Report.)—Using Jaggar's microsclerometer the following figures were obtained:—

Constituent.	Present in	Average Hardness.	Ratio.
Ferrite ...	Electrolytic iron	460	1
„	„ „ , quenched	990	2·15
„	Average of all unhardened samples ...	610	1·08
„	Commercial wrought irons	686–1,648	1·5–3·6
Pearlite ...	Series 0·18–1·52 per cent. carbon	842–4,711	1·8–10·3
„	Series 0·35–0·86 per cent. carbon	1,745–2,150	3·8–4·2
Sorbite ...	0·48 and 0·58 per cent. carbon............	2,400–24,650	5·2–53·6
Troostite...	Steel, 0·58 per cent. carbon	40,564	88·2
Martensite	Series 0·20–1·52 per cent. carbon	17,896–120,330	38·9–261·6
Austenite...	White cast-iron (3·24 per cent. carbon)	47,590	103·4
Cementite	Ditto ditto	125,480	272·8

F. R.

6. *Strength of Steel under Combined Stresses.* **W. A. Scoble.** (Phil. Mag. 12. pp. 533–547, Dec., 1906. Paper read before the Physical Soc., Oct. 26, 1906.)—As a result of experiments in which torsional and bending loads were simultaneously applied to a ductile steel, the author concludes that the maximum shear stress determines yield, but this will vary slightly on account of the difference of shear resistance in different directions; the theory of the existence of a frictional force on shearing planes proportional to the force normal to the planes is disfavoured. Values of the max. shear stress at yield were obtained ranging from 29,170 lbs. per sq. in. with torsion only, to 32,300 lbs. with bending only, and somewhat higher in a few instances of combined loading. For the common case of combined loading either the circular or elliptic formula may safely be used, or to approximate to the elliptic, equivalent moment $= \sqrt{(M^2 + T^2)}$ may safely be used, taken as being of the same kind as the greater of the two. Yield having been taken as the criterion, it is pointed out that these formulæ may not be extended as yet to brittle materials. F. R.

7. *Microscopic Effects produced by the Action of Stresses on Metals.* **F. Rogers.** (Soc. d'Encouragement. Rev. de Métallurgie, Mém. 3. pp. 884–893, Oct. 1, 1906.)—Gives further details and photo-micrographs of the author's earlier experiments on the effect of alternating stresses on steels [see Abstract No. 1805 (1905)]. The result chiefly emphasised is that the more a steel is overheated, the wider apart and the less "broken" are the slip-bands observed upon it after exposure to either alternating or static stress. The "broken" slip-bands are regarded as produced by frequent stepping of the surfaces of slip from one cleavage plane to another, and the author suggests reasons, based upon considerations of the probable internal stresses existing between and within the crystals, why this stepping should occur in iron and steel and only to a much smaller degree in lead and copper. The author deals with criticism of his earlier papers by Osmond and Frémont, controverting their views as to the nature of deformations and upholding the view of Rosenhain as to the truly crystalline character of slip-bands. W. Ros.

8. *Behaviour of Cast Iron under Small Elastic Extension.* **E. Grüneisen.** (Deutsch. Phys. Gesell., Verh. 8. 20. pp. 469–477, Oct. 30, 1906. Paper read before the 78 Naturforscherversamml., Stuttgart, Sept. 19, 1906. Communication from the Physikal.-Techn. Reichsanstalt. Phys. Zeitschr. 7. pp. 901–904, Dec. 1, 1906.)—The following are the results of the author's determinations of the elasticity of cast irons, by (*a*) direct stress, using a Newton's rings method for observing extension, and (*b*) by transverse vibration of bars; stresses and the corresponding moduli are in kg. per sq. cm.; the several readings in the static method show the change of the moduli at very low stresses:—

Cast Iron.	Stress.	$E \times 10^{-2}$, Static.		$E \times 10^{-2}$, by Vibrations.	Temperature.
G K	0 1·576 3·457 5·332 7·215 9·042	10,603 10,588 10,571 10,554 10,536 10,520	Average. 10,540	—	17·8° C.
	—	—	—	10,510	19° C.
A	—	—	13,290	—	16·4° C.
	—	—	—	13,480	18° C.

These are then compared with results obtained by Bach with the same metals, and it is shown that the formulæ of Hartig and Schüle agree fairly well with these results. F. R.

9. *Heating of Metals by Tension.* **H. Hort.** (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1831–1837, Nov. 10, 1906. Göttingen Inaugural Dissertation, 1906.)—The temperatures at three points of specimens of iron, copper, and steel tested in tension were observed. Further calorimetric work gave the following results:—

Specimen.	Work done on the Specimen, Kg.-Cm.	Latent Heat.	
		Per cent. of Work done on Specimen.	Gm.-Cals. per Gm.
I. Purest Krupp iron, annealed	5,070 3,080	10 3 to 5	0·0739
II. Ditto, unannealed	2,620 4,520	15 10	0·0906

The amounts of work were additive for each specimen, and the loads proceeded to were slightly short of rupture. The amounts of heat not latent, *i.e.*, those which raised the temperature of the calorimetric fluid, were roughly proportional to the corresponding maximum loads sustained by the specimens from 5 to 10 min. after unloading. F. R.

10. *Experiments on Reinforced Concrete.* **W. H. Warren.** (Roy. Soc. N.S. Wales, Journ. and Proc. 39. pp. 49–64, 1905.)—Gives results of experiments on plain and reinforced beams with a uniform bending moment, strains being measured by numerous Martens' extensometers and sectors. For purposes of design, the shearing stress in concrete and the adhesion of the concrete to the steel (joint in shear) are given as 50 lbs. per sq. in., the compressive and shearing stresses in the steel as 12,000 and 10,000 lbs. per sq. in. respectively. It was found that with increasing load the neutral axes of beams gradually moved towards the compression side, the maximum deviation in a 10 in. × 10 in. section, plain concrete, being 0·3 in., whilst it is more than 2 in. in reinforced beams. In the former case the neutral axis remains practically central until the load exceeds ⅓ of the breaking load. Initially plane sections deviate more and more from planes with increasing bending moments. [See also Abstract No. 268 (1906).] F. R.

11. *Activity of the Royal Depôt for testing Materials, Gross-Lichterfelde West, in* 1905. (Königl. Materialprüfungsamt, Mitt. 24. 3. pp. 117–174, 1906. Engineering, 82. p. 873, Dec. 28, 1906. Abstract.)—The work carried out in the different departments is described. Among the results of physical interest, the effect of heat on wrought-iron steam pipes, shaped steel castings, boiler-plate metal, and bronze was investigated. The steel castings and the boiler-plates show at 200° C. a higher tensile strength and a smaller elongation than at room temperatures. In the case of bronze, the tensile strength decreases with increase of temperature (from 5,890 at room temperature to 2,340 kg./cm.^{2} at 400° C.); the elongation also decreases, being only 13 per cent. at 300° C. (36 per cent. at room temperature), but it rises to 32 per cent. again at 350° C. Tests of raw-hide pinions gave a breaking load of about 340 kg./cm.^{2}. The linear expansion of nickel-aluminium between 18° and 62° C. is found to be 0·0000214 per 1° C. The corrosion of iron by water containing air was examined with special reference to the question as to whether the contact of superheated with non-superheated iron has any influence on such corrosion. It is found that the contact has a decided effect. A low-carbon wrought-iron plate had pieces taken from it. Part of these were annealed at 900° C. for 30 min., and others for 2 hours at 1,300° C. The latter were then in the superheated, the former in the non-superheated state. Pairs of such superheated and non-superheated plates, metallically joined by an iron bar of the same material, were completely immersed in distilled water whose surface was exposed to the air. The following figures show the loss in weight due to rusting ;—

	After 14 Days.	After 26 Days.
Superheated plate	0·0461 gm.	0·0829 gm.
Non-superheated plate	0·0604 gm.	0·1149 gm.

The non-superheated iron in contact with the superheated plate is thus more strongly attacked, the relative loss being, taking the loss in superheated plate as 100, 131 after 14 days and 138 after 26 days. The non-superheated iron thus protects the superheated metal and behaves like zinc does towards iron, but is itself more strongly attacked. This increased liability to attack is confirmed by potential measurements with the non-superheated metal against the superheated metal, in distilled water; the former is much more strongly positive, the p.d.'s being quite considerable and sometimes as much as 0·3–0·4 volt. This behaviour of iron is of great practical importance in connection with the corrosion of welded places in steam boilers. Through the welding the metal *may* be brought into the superheated condition, which will cause the non-superheated neighbouring regions to be strongly attacked. With properly carried out welding, in which the weld is worked, either by hammering or pressure, from the welding heat down to about red-heat, this should not occur. Metallographic examination combined with impact bending tests can decide as to the condition of the iron. The elasticity of concrete was also examined, and the effect of iron reinforcement upon the linear expansion with change of temperature. Using prisms of 20 × 20 cm. cross-section and 75 cm. long in which 8 iron bars of 5 × 0·6 cm. cross-section were embedded, the expansions in the range −2° to +50° C. were, per unit length and per 1° C., 94, 109, and 111, all times 10^{-7}, for plain concrete, and 101, 115, and 117, all times 10^{-7}, for the concrete with iron reinforcement. L. H. W.

12. *Condensation Nuclei: Drop of Pressure in the Fog Chamber.* **C. Barus.** Amer. Journ. Sci. 22. pp. 339–341, Oct., 1906.)—The author's apparatus for condensation consists of a fog chamber in communication with a vacuum chamber through a wide stop-cock. The computed isothermal pressure in the closed fog chamber is from 2 to 5 cm. above the nominally isothermal pressure observed in the experiments. For the region in which colloidal nuclei lie the correction will be 6 to 8 cm. This is in excess of the difference between the pressure regions in which Wilson's data for colloidal nuclei and the region in which the author's data would lie, *i.e.*, the data in the case of the author's large coronal apparatus lie in regions of exhaustion at least as moderate as those observed in Wilson's small apparatus. It may be considered proved that a limit has been reached for condensations within the given type of fog chamber. J. J. S.

13. *Flow of Liquids through Capillary Spaces.* **J. M. Bell** and **F. K. Cameron.** (Journ. Phys. Chem. 10. pp. 658–674, Nov., 1906. By permission of the U.S. Secretary of Agriculture.)—The authors have studied the movement of aqueous solutions through porous materials, and find that the empirical equation $y^n = Kt$, where y represents the distance through which the liquid has moved in the time t, and n and K are constants, describes the movement of water and solutions through porous materials, such as filter-paper and dry soils. The value of n lies above 2 in most cases. The same equation also describes the movement through soils and paper of solutions which suffer change during the process. Both the advance of the solute and of water in the medium are described by the equation. A. F.

14. *Surface Tension of Fused Sulphur.* **H. Zickendraht.** (Ann. d. Physik, 21. 1. pp. 141–154, Oct. 25, 1906.)—The experimental method was essentially that used by Simon in 1851 and by Cantor in 1892; a stream of gas at a known pressure was made to bubble slowly through the liquid sulphur. According to Cantor's theory, the surface tension, a, is equal to $(r/2)p$, where r is the inner radius of the gas inlet tube, and p is the pressure of the gas. The data obtained show that (1), a diminishes gradually from the melting-point to 160°, where the value is a minimum (about 6 mgm./mm.); (2), from 160° to 250° (where $a = 12$ mgm./mm.) there is a marked increase in the value of the surface tension; (3) from the maximum at 250°, a falls rapidly to the value 6 mgm./mm. at 300°; (4) above 300° there is a very gradual fall to the value 4·5 mgm./mm. at the boiling-point of sulphur. The author holds that the results show the existence of a new modification of sulphur (δ-sulphur) characterised by a distinct value of the surface tension, viz., 12 mgm./mm. The formation of δ-sulphur begins at about 160°; in the neighbourhood of 300° we have a transformation of δ-sulphur into amorphous (γ) sulphur. D. H. J.

15. *Pendulum Observations at Kew and Greenwich.* **G. P. Lenox-Conyngham.** (Roy. Soc., Proc. Ser. A. 78. pp. 241–247, Nov. 5, 1906.)—These observations formed part of the new series started by the Indian Government, in continuation of the former work concluded in 1870. Apparatus designed by v. Sterneck was employed, consisting of four half-seconds pendulums, made of brass heavily gilt, and provided with agate knife-edges. Near the top of each pendulum is a small mirror, by means of which the swings are observed from a distance by a small telescope. In both cases the observed values were in slight excess over those calculated, and the difference between them greater than the calculated difference. C. P. B.

16. *Physiography of the River Nile and its Basin.* (Nature, 75. pp. 17–20, Nov. 1, 1906.)—Comments on the monograph of this title by H. G. Lyons, Director-General of the Egyptian Survey Department, with special regard to meteorology. The Nile basin may be divided into three areas, not much differing in breadth: The equatorial belt, latitude 5° S. to 5° N., with Lakes Victoria (level 4,000 ft.), Albert Edward, and Albert; Sudan and Abyssinia, up to 18° N.; and the Lower Nile, up to the Mediterranean and latitude 34° N. In the equatorial belt temperature is remarkably uniform. The Sudan, with meteorological stations at Khartoum, Berber, Dongola, average altitude 1,200 ft., is the hottest part of the basin, and hotter than Upper Sind; the difference in the mean temperature of Berber and Alexandria increases from 8° F. in January to 16° F. in April and May. The air pressure is less well known than the temperature. From June to September a low pressure area seems to extend from the Sudan across to Upper India, divided probably by a belt of somewhat higher pressure across the Red Sea. The air movements are of the monsoon type in the equatorial belt up to latitude 17° N.; northerly winds predominate further north, south-easterly winds south of the equator. Abyssinia, India, Burma, and the Malay Peninsula receive their rainfall from the Indian Ocean under the same meteorological conditions. The rainfall in Abyssinia, as indicated by the Nile floods, is subject to a much larger range of variation than the rainfall in India, but the two run parallel. From 1892 to 1894 the rainfall in India and the Nile floods were in excess of the normal, from 1895 to 1897 normal, from 1898 to 1905 below normal. The Victoria Lake was at high level from 1892 to 1895, at falling level from 1896 to 1902, and rose again in 1903. The causes of these remarkable parallelisms are considered, reference being made to Lockyer's views. H. B.

17. *Snow Rollers.* **W. A. Bentley.** (Monthly Weather Rev. 34. pp. 325–326, July, 1906.)—Snow fell after sharp frost during the night of January 18, 1906, at Jericho, Vermont, and snow rolls were formed afterwards, while the temperature rose to 34° F. Snow mats seemed to have been rolled up by the wind to diameters of 24 in. maximum; the length of the roll was generally greater than the diameter. In some cases the core of the roll was hollow. H. B.

18. *Concurrence and Interrelation of Volcanic and Seismic Phenomena.* **A. Heilprin.** (Science, 24. pp. 545–551, Nov. 2, 1906. Paper read before the Tenth Internat. Geological Congress, Mexico, Sept. 6, 1906.)—Referring particularly to Japan and the Gulf of Mexico, the author points out that most earthquakes were preceded by magnetic disturbances. Displacements along lines of fault are consequences of seismic jars rather than the cause of earth-

quakes. Interrelated manifestations of volcanic and seismic activity may extend over thousands of miles; the Lisbon earthquake of 1755 and the Calabrian earthquake of 1788 were probably connected with eruptions in Iceland, where enormous masses were discharged from volcanoes; the disturbances of the Mississippi Valley in 1811 and 1812 ceased with the eruption of the Soufrière (St. Vincent) in 1812. In agreement with Milne the author considers that the distinction between volcanic and tectonic earthquakes is doubtful. All these disturbances are expressions of telluric strain, associated with a pronounced magnetic or electromagnetic quality of the planet.

H. B.

19. *The Superior Tangent Arc to the Halo at* 46°. **L. Besson.** (Comptes Rendus, 148. pp. 718–715, Nov. 5, 1906.)—Last year the author reported an observation of a rainbow-coloured arc at 59° above the horizon, the sun's altitude being then 8°. [See Comptes Rendus, April 8, 1905.] The height, 59°, is precisely that which, according to Bravais' theory, the arc called the superior tangent arc to the 46° halo, or circumzenithal arc, should have for the solar altitude quoted. Bravais believed that this arc could not be seen when the sun's altitude was less than 12° or greater than 31°. Since the above observation, however, the author has witnessed the same phenomenon on three occasions, the sun's altitude having been 10°, 11°, and 5° respectively. It would therefore appear that a circumzenithal arc with a solar altitude under 12° is not such a rare phenomenon as has hitherto been supposed. The author made a large number of measures of the height of the arc, and of the accompanying halos, and the results, especially those showing gradual variation of the height of the arc above the sun, tend to fully bear out Bravais' theory.

A. E.

20. *Brightness of Inner Edges of Sun-spot Penumbræ.* **S. Chevalier.** (Astrophys. Journ. 24. pp. 278–284, Nov., 1906.)—The phenomenon of a local increase of brightness towards the inner edge of the penumbra having been doubted by several writers, the author gives reproductions from photographs obtained at the Observatory of Zo-Sè, China, showing conclusively that the effect is a true one in at least some cases. It is further shown that the appearance varies greatly in different spots, so that some observers may have missed it in this way. For each sun-spot there is not any apparent variation in this phenomenon, resulting from its place over the disc. It must, however, be noted that the first appearance of it comes out on the north and south of the nucleus, when the spot is entering on the visible hemisphere; then on the east, and finally on the west side. When the spot is approaching the west limb, the disappearance begins with the east side, then the west, and finally the north and south. It is just the same as for the penumbra itself. A wide difference is thus shown between the brightness of the inner edge of the penumbra and the brightness of the faculæ. There is a strong probability that the sun-spots of a regular shape present this phenomenon with a more marked brilliancy.

C. P. B.

21. *Observations of Contact during Total Eclipses.* **C. André.** (Comptes Rendus, 143. pp. 806–809, Nov. 26, 1906.)—The case of external contacts is first considered. At the last eclipse, of Aug. 30, 1905, the first and fourth contacts were observed by projection by the French observers at Guelma and Roquetas. The results for the two observers of each station were very concordant—at Guelma, in fact, the times recorded for first contact coincided, while those for fourth contact only differed by 0·2s. On comparing the results, however, with the calculated elements in *Connaissance des Temps*, the following values for the differences "computed—observed" are found :—

	First Contact.	Fourth Contact.
C—O at Guelma	+ 12·9s.	+ 23·6s.
C—O at Roquetas	+ 14·4s.	+ 23·5s.

Thus in all four cases the observation was in advance of calculation, and, what is especially remarkable, the difference was twice as great at the end of the eclipse as at the beginning. Hence the difference does not merely represent the correction due to error in the adopted lunar elements, which may be called the theoretical correction, Δc, and should affect beginning and end alike. Let Δt be the part of the total correction depending solely on practical errors of observation, then in general $C + \Delta c = O + \Delta t =$ true time of contact. We should naturally expect the first contact (occurring just before the encroachment of the shadow) to be observed late, and the fourth contact to be observed too early, so that Δt will be negative for entry and positive for exit. Further, considerations of symmetry make it seem probable that the numerical values of Δt will be nearly the same at the entry and exit ; they are assumed equal. Thus we get—

$$\text{For first contact } (C—O)_1 = -\Delta c - \Delta t$$
$$\text{For fourth contact } (C—O)_4 = -\Delta c + \Delta t.$$

Hence the values of C—O are different for the two contacts, and Δt equals half their difference, and $-\Delta c$ equals half their sum. For instance, the Guelma results give $\Delta t = 5{\cdot}3$s., $\Delta c = -18{\cdot}25$s. When the method of direct observation is employed the question of personal error grows more complicated, and the second and third contacts were observed directly by all those fortunate enough to witness totality. However, by using the theoretical correction, as derived above, to determine the time of true contact, information respecting the observational errors can be deduced. The second contact (beginning of totality) appears to have been generally observed a little late, and the third contact early, one decided exception being attributable to too great reduction of aperture. A. E.

22. *Period of β Cephei.* **E. B. Frost.** (Astrophys. Journ. 24. pp. 259–262, Nov., 1906.)—Photographs taken at the Yerkes Observatory show that the star's radial velocity passes through its whole cycle of changes even in a short summer night. Provisional measures indicate a range of velocity (on the 2-prism plates taken with short exposures) of about 34 km., from about + 12 km. to about —22 km. This implies a velocity of —5 km. for the system, and an orbital velocity of 17 km. per sec. The period of variation is computed as 4h. 34m. 11s. On some of the plates certain lines have the appearance of complexity, and indicate the presence of the spectrum of a second component. The spectrum is an excellent example of the Orion type, with fairly sharp silicon lines in addition to those of He, H, O, and Mg.

C. P. B.

23. *Stars with Peculiar Spectra.* **H. Ludendorff.** (Astronom. Nachr. No. 4129. Nature, 75. p. 64, Nov. 15, 1906. Abstract.)—Discussion of the spectra of R. Coronæ, 12 Canum Venaticorum, and 72 Ophiuchi, from photographs obtained with the three-prism spectroscope at Potsdam. In the spectrum of R. Coronæ the hydrogen lines H_β, H_γ, H_δ are invisible; the H and K lines of calcium are broad. Radial velocity about + 24·6 km.

C. P. B.

REFERENCES.

24. *Lateral Vibration of Bars subjected to Forces in the Direction of their Axes.* **J. Morrow.** (Phil. Mag. 12. pp. 233–243, Sept., 1906. Paper read before the Physical Soc., April 27, 1906.)—In this paper are considered the following: Supported massive bar, Clamped-clamped massive bar, Clamped-supported massive bar, Supported loaded massless bar, Clamped loaded massless bar, Static problems. [See Abstract No. 681 (1906).]

25. *Economical Proportions in I-beam Sections.* **R. H. Smith.** (Engineer, 102. pp. 463–465, Nov. 9, 1906.)—Develops a method of design from the physical side, whilst introducing practical limitations. The results are summarised in the form of a series of rules, a table and curves, but do not admit of brief abstracting.

F. R.

26. *Testing of Clay and Concrete Pipes.* **M. Gary.** (Königl. Materialprüfungsamt, Mitt. 24. 2. pp. 83–92, 1906. Report laid before the Internat. Assoc. for Testing Materials, at Brussels, 1906.)—The methods adopted by the Materialprüfungsamt are described, and the apparatus employed is illustrated. **H. Burchartz.** (Eng. Record, 54. pp. 190–193, Aug. 18, 1906.)—A summary of the above report.

27. *Propulsive Power of Screws Necessary to Avoid Cavitation.* **J. A. Normand.** (Inst. Civil Engin., Proc. 165. pp. 293–298, 1905–1906.)

28. *Cavitation of Screw Propellers.* **S. W. Barnaby.** (Inst. Civil Engin., Proc. 165. pp. 299–308, 1905–1906.)

29. *Pendulum Observations.* **A. Prey.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 649–672, May, 1906.)—A mathematical investigation of the effect of air-resistance and of the loss of kinetic energy suffered by the pendulum due to its imparting some of its motion to the surrounding air.

30. *Stereophotogrammetry from Balloons for Topographical Purposes.* **A. Schell.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 485–522, May, 1906.)—A full consideration of the best conditions, such as balloon height and steadiness, type of apparatus and plate, and of the errors involved.

31. *Gravitation.* **V. Crémieu.** (Comptes Rendus, 143. pp. 887–889, Dec. 3, 1906.)—Describes researches on the propagation of gravitation through liquids, from which it is inferred that in a very convergent gravitational field a body plunged in a liquid experiences rather more than the difference between the hydrostatic pressure and the Newtonian attraction. [See also Abstract No. 274 (1906).]

E. H. B.

32. *Acceleration of Gravity at Johannesburg.* **R. A. Lehfeldt.** (Phil. Mag. 12. pp. 479–481, Nov., 1906. Paper read before the South African Assoc. for Advancement of Science, Kimberley, 1906.)—The determination was made as a first investigation of the distribution of gravity over the South African Tableland, and the result obtained is in good agreement with the requirements of Helmert's formula; $g = 978·7$.

C. P. B.

33. *Midnight Sky Illumination at Summer Solstice.* **E. E. Barnard.** (Astrophys. Journ. 24. pp. 128–129, Sept., 1906.)—From observations made during the last summer it is concluded that the illumination of the northern horizon at midnight must be at least partly due to the zodiacal light. Details of various estimations are given, from which it appears that the light must extend at least 65° north and south of the sun (assuming the southern extent to be as great as the northern). This is greater than the limits suggested by Newcomb [Abstract No. 697 (1906)]. C. P. B.

34. *Colours of Sun-spots.* **T. Hansen.** (Nature, 74. pp. 548–549, Sept. 27, 1906. From Bull. de la Soc. astronomique de France, Sept., 1906.)—From many years' observations of sun-spots the author considers they have distinctive colours. The spot umbræ are rarely, if ever, dead black, but generally violet tinted. The preceding part of a spot is often yellow, while the following portions often assume a red colouration, or more rarely green. Coloured drawings indicating the observations made accompany the paper. C. P. B.

35. *Rotation Period of Jupiter's Equatorial Region.* **W. F. Denning.** (Astronom. Nachr., No. 4117. Nature, 74. p. 549, Sept. 27, 1906. Abstract.)—The paper contains the determined rotation periods for a number of spots on the equatorial side of the southern equatorial belt of Jupiter, measured at Bristol during the interval 1898–1906. It is shown that the rate during 1905–6 was several seconds slower than in previous years. C. P. B.

36. *Satellites of Jupiter and Saturn.* **Barnard.** (Astronom. Nachr., Nos. 4112, 4116. Nature, 74. pp. 499–500, Sept. 13, 1906. Abstract.)—As seen with the Yerkes refractor during February and March, 1906, the sixth satellite of Jupiter appeared of about magnitude 14·0. Phœbe, the ninth satellite of Saturn, was observed on July 24 and 29, being of magnitude 16·5, and at times appearing hazy. C. P. B.

37. *Radium and Geology.* **O. Fisher.** (Nature, 74. p. 585, Oct. 11, 1906.)—The author points out that if Strutt's explanation of the temperature gradient of the earth's crust be accepted, it follows that the earth must be in a state of thermal stability. This is at variance with the observations and deductions made by geologists. [See Abstracts Nos. 1235 and 1877 (1906).] **B. J. Palmer.** (Ibid. p. 585.) E. C. C. B.

38. *Circulation of the Atmospheres of the Earth, the Sun, and of Jupiter.* **L. de Marchi.** (N. Cimento, 12. pp. 61–80, July and Aug., 1906. From Reale Istituto Veneto, Atti, Vol. 65 (Vol. 8 of Series 8), 1906).—Incited by Hergesell's observations [see Abstract No. 519 (1905)] the author discusses mathematically the conditions of the atmospheric circulations. The conclusions are in the main in accord with Hergesell's results, but the original should be referred to as the paper does not lend itself to abstracting. L. H. W.

39. *Magnetic Disturbances attributed to the Calabrian Earthquake of Sept.* 8, 1905. **G. B. Rizzo.** (Terrestrial Magnetism, 11. pp. 113–124, Sept., 1906. In Italian.)—From collected observations it is concluded that (1) the earthquake was recorded on most magnetic instruments up to a distance of about 1,900 km. from the epicentre. (2) The times of disturbances coincide with those of the principal phase of the seismic motion. (3) It is probable that the disturbances are caused by oscillations of the ground at the place of observation. L. H. W.

40. *Apparent Form of Celestial Vault.* **R. D. v. Sterneck.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 547–588, May, 1906.)—Discussion of the varying forms presented by the celestial vault under different conditions, *e.g.*, sunlit, cloudy, twilight, night, &c. C. P. B.

LIGHT.

41. *New Spectrograph for Visible and Ultra-violet Light.* **F. Löwe.** (Zeitschr. Instrumentenk. 26. pp. 330–333, Nov., 1906. Communication from the optical works of C. Zeiss, Jena.)—A new and modified form of Pulfrich's spectroscope is described. One feature is the employment of three kinds of pointer on a single circular rotatable plate. The points are—a cross; a single line, to be set up on centre of spectrum line; a pair of lines between which the spectrum line under measurement is adjusted. The change from visible to ultra-violet spectrum observation is made by simply changing the objective and the half-prisms. The deviation of the quartz prisms for the mean colour ($\lambda = 275\,\mu\mu$) of the ultra-violet spectrum is the same as that of the Rutherford prisms for the F line of the visible spectrum, hence no new setting of the camera is required in making the change. L. H. W.

42. *Modification of Pulfrich's Formula for the Refractive Index of a Mixture of Two Liquids.* **V. F. Hess.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 459–478, May, 1906.)—The author assumes a contraction of Lorentz's expression $R = (N^2 - 1)/(N^2 + 2)$ to be proportional to the contraction in volume. Thus $(R - R_v)/R = \beta(D - D_v)/D$. The refractive index is then found in terms of β and R, and the expression tested for a number of liquids. It is found that, in those cases in which Pulfrich's formula gives poor results, β is nearly constant; and in all cases the author's formula is more in accordance with the measurements than that of Pulfrich. [See Abstract No. 78 (1906).] S. G. S.

43. *Optical Properties of Liquid Crystals of Ammonium Oleate.* **F. Wallerant.** (Comptes Rendus, 143. pp. 694–695, Nov. 5, 1906.)—A drop of liquid-crystalline ammonium oleate compressed between a microscope glass and a cover slip-appears turbid and polarises irregularly. If, however, the cover-slip is tapped with a needle the liquid becomes clear and gives rise to a perfect uniaxial figure, with black cross and coloured rings complete; a photograph of this is given in the paper. Examination with a quarter-wave plate shows the double-refraction to be positive. The orientation of the particles of the film when once developed shows remarkable stability. The oleate shows four polymorphic modifications. A little below 40° C. the uniaxial crystals just described become biaxial, the axes being very close together, and the double refraction strong and negative; the crystals are perfectly limpid. Further cooling causes the formation of positive biaxial crystals, with optic axes separated by about 60 degrees in air. A fourth and labile modification is produced by crystallising the oleate from solution and fusion. T. M. L.

44. *Interference Rings Observable by Plates whose Surfaces are absolutely Parallel.* **Rayleigh.** (Phil. Mag. 12. pp. 489–493, Nov., 1906.)—The importance which these rings have acquired in recent years, owing to the researches of Michelson and of Fabry and Perot, lends interest to the circumstances of their discovery. It seems to be usually supposed that Haidinger merely observed the rings, without a full appreciation of the mode of formation. But it is here contended that Haidinger, in spite of one or two slips, understood the character of the rings very well, and especially the distinction between them and the rings usually named after Newton, and dependent upon a variable thickness in the thin plate. In the first memoir (1849) the bands formed by *reflection* are especially discussed. A spirit-flame with salted wick, seen by reflection at considerable obliquity in a mica plate, is traversed by approximately straight bands running perpendicularly to the plane of incidence. Talbot had observed yellow and black lines in thin blown glass, but these were due to the variable thickness, and the lines are localised in the plate. The lines from the mica behave differently. However the plate may be turned round in its own plane, the yellow and dark lines remain perpendicular to the plane of incidence. The two surfaces of the mica are absolutely parallel to one another, and accordingly the phenomenon is the same in all azimuths. The lines appear sharper and more distinct the nearer the mica be held to the eye, in contradistinction to the lines from glass, which then become more and more indistinct and finally disappear. The bands are due to interference of light reflected at the two surfaces. The difference of path for the rays reflected at the front and back surfaces amounts for the bright bands to a whole number of wave-lengths *plus* a half-wave-length; for the dark bands, to a whole number of wave-lengths simply. At this time Haidinger had not succeeded in seeing the complete rings, but in a later memoir (1854) he returns to the subject and shows how the obstacle to the incident light caused by the head of the observer may be overcome with the aid of a glass plate inclined at 45°. The incident light on its way to the mica is reflected at the glass plate, while on its return it traverses the plate and so reaches the eye. The observation of the transmitted rings is of the simplest character. It is sufficient to look through the plate of mica at a sheet of white paper illuminated either from in front or from behind by the homogeneous light of the spirit-flame. The rings are complementary to those seen by reflection. They are, however, much less intense, being due to the interference of the powerful directly-transmitted light with the much feebler light twice reflected in the interior of the plate. The distinction between contact rings and plate rings is again emphasised, the former depending upon a variable thickness, the latter upon a variable obliquity. The present author has experimented especially with two plates of mica, 0·185 mm. and 0·218 mm. thick, and has observed some novel effects, evidently dependent upon the double refraction of the mica, hitherto, it would seem, not taken into account. Very cursory observation on these plates, held squarely, showed that with the thinner plate the inner rings were well seen, while with the thicker one they were not. It was at first suspected that the complication might be due to a double system of rings, corresponding to the two D lines, accidentally coincident in the first case, but interfering with one another in the second. It soon appeared, however, that the duplicity of sodium light was not the cause. The substitution of a *helium* vacuum-tube for the salted Bunsen flame made no material difference. It is only near the centre of the system that the rings are obscured when the thicker plate is used without a nicol. Further out the rings become distinct enough, except that along four directions, apparently at right angles, radiating from the centre, there are regions of no definition. These regions are narrow, and constitute, as it were, *spokes* of the ring system. It was then found, on closer examination, that in the spokes the rings were still there, but were seen to consist of two systems, in which the bright rings of each system alternated, whereas in the clearer parts away from the spokes the bright rings of each of the two systems fell nearly together. The fact that the two concentric ring systems cross one another proves that they cannot be strictly circular. There is no difficulty in repeating Haidinger's observation. The transmitted rings are best seen by holding the mica close to the eye (focussed for infinity) and immediately in front of a piece of finely-ground glass, behind which is placed a salted Bunsen flame. According to Wood, the salting is best effected with the aid of a piece of asbestos, previously soaked in brine, wrapped round the tube of the Bunsen and forming a prolongation of it.

E. H. B.

45. *Optical Properties of Metallic Films.* **R. C. Maclaurin.** (Roy. Soc., Proc. Ser. A. 78. pp. 296–341, Nov. 5, 1906.)—One of the earliest workers in this field was MacCullagh. He predicted from theory and verified by experiment that if light incident on a gold leaf were plane polarised, the transmitted beam would be elliptically polarised. With the improvement in experimental methods since MacCullagh's day, and the gradual removal of obscurities from the theory of metallic reflection and transmission, we now expect much more than a general agreement between theory and experiment. We look for an almost exact numerical coincidence. The condition of the reflected or transmitted beam is precisely described by means of two quantities, the ellipticity and the difference of phase between the components of the light polarised perpendicular and parallel to the plane of incidence. The object of the present paper is to obtain convenient formulæ for these quantities and to compare them with the results of experiments, the most careful and recent ones being selected. Since extreme tenuity can be obtained only by depositing the metal chemically or electrically on some other material, such as glass, this case is carefully treated. The reflections and transmissions are dealt with at each of the four interfaces of the series—air, metal, air, glass and air. The numerical values found are embodied in tables and graphically exhibited by curves in twenty-four figures, which should be consulted for the detailed information. The agreements with experiment are in some cases quite satisfactory.

E. H. B.

46. *Optical Properties of Carbon Films.* **H. A. Clark.** (Phys. Rev. 23. pp. 422–443, Nov., 1906. Paper read before the Amer. Physical Soc., in part in April, 1905, and in part in Dec., 1905.)—The present work deals with the reflection, refraction, and absorption of carbon films, all determined by direct methods from the same samples of pure carbon in a dense form. The results may be summarised as follows: (1) The reflection, the absorption, and the refractive index of carbon films vary with the conditions of deposit. Thus, one kathodic film gave for sodium light $\mu = 1{\cdot}588$ by the spectrometer, and 1·608 by the interferometer; and another kathodic film gave 1·645 by the spectrometer; whereas an incandescent-lamp film gave $\mu = 1{\cdot}602$ for sodium light by the interferometer. (2) There is a slight anomaly in the refractive index of kathodic carbon films, and a more pronounced one in the case of incandescent-lamp films, at the wave-length $\lambda = 610\,\mu\mu$. The reflection curves of the former show a corresponding variation. (3) The transmission of kathodic films decreases almost uniformly from the red of the visible spectrum to the wave-length $\lambda = 266{\cdot}6\,\mu\mu$, beyond which the films are completely opaque. Thus there is no pronounced absorption band. (4) The reflection of kathodic films *decreases* from a maximum in the red to a minimum in the blue of the visible spectrum. A slight rise, however, occurs at the wave-length $\lambda = 630\,\mu\mu$.

E. H. B.

47. *Optical and Electrical Measurements at the Boundary Layer, Metal-electrolyte.* **W. J. Müller** and **J. Koenigsberger.** (Deutsch. Phys. Gesell., Verh. 8. 21. pp. 545–558, Nov. 15, 1906. Paper read before the 78 Naturforscherversamml. Stuttgart, Sept. 18, 1906.)—The authors have extended their previous investigations [see Abstracts Nos. 59, 80 (1906)] and here give a summary of the results obtained with films of PbO_2, Ag, Zn, Cu, Pd, Cr, Ni, Al. (1) Coherent oxide films of molecular thickness are optically noticeable. (2) Non-coherent layers affect the reflecting power of a metallic mirror even in quantities which, reckoned as a film, are near to the lowest limit of molecular diameter. (3) PbO_2 forms a coherent film; metals (Ag, Zn, Cu) do not. (7) Passive chromium, made passive in KI-solution, shows a greater reflective power than active Cr; chromium mirrors which are not electrically polarised become coated in KI-solution with a badly-reflecting layer which is removable with difficulty; passive Cr is *not* covered with any oxide layer. (8) Aluminium mirrors when anodically polarised are covered at once with a badly-reflecting, permanent hydroxide film. L. H. W.

48. *Colour Filters for Astronomical Photography.* **R. J. Wallace.** (Astrophys. Journ. 24. pp. 268–277, Nov., 1906.)—Colour filters are employed with refracting telescopes to correct the want of achromatism of the lens, and also to limit the acting rays to certain colours depending on the particular plates employed. In the case of the image given by a reflecting telescope, however, this does not appear to have received much attention, probably owing to the fact of the reflector being perfectly achromatic. When an image of a celestial object given by a mirror is photographed on a certain plate, however, the result will not be true unless the plate is also perfectly sensitive to all colours throughout the spectrum. This discrepancy is specially noticeable in the case of direct stellar photography, which becomes considerably worse when "extra focal" images are employed, as in the methods of photographic photometry. Even when using isochromatic plates the max. sensitiveness is still towards the violet end of the spectrum. Numerous experiments were undertaken to determine the most suitable dyes for preparing filters to correct the plates for this inequality, and a final selection was made of tartrazine, auramine O, metanil yellow S, nitrosodimethylanilin. Gelatinous solutions of these dyes were made and flowed over glass plates inclined at suitable angles so as to produce wedges of absorbent. These were spectroscopically examined at intervals of 1 cm. Using Cramer instantaneous isochromatic plates, having a comparatively low sensitiveness to the blue-green at λ 5050, a combined filter made up of tartrazine and æsculin was found most suitable. An illustration is given showing the components of the star U Cygni, taken with and without the filter. C. P. B.

49. *Photometric Measurements by a Person possessing Monochromatic Vision.* **F. L. Tufts.** (Amer. Journ. Sci. 22. pp. 531–533, Dec., 1906.)—In O. N. Rood's paper [see Abstract No. 27 (1899)] the results of measurements made by means of the flicker photometer on persons possessing normal vision and on three persons having red colour-blindness are given. The author describes experiments on J. T., who has monochromatic vision. The flicker photometer and the red, green, and blue plates of glass were the ones Rood used in his tests. The c.p.'s of two glow-lamps, A and B, were compared by means of the flicker photometer, first directly and afterwards when each of the three glasses was placed in turn between the lamp A and the photometer wedge. The comparisons were made by W. S. Dennett, the Author, and J. T. The

mean of from 10 to 20 readings was taken in each case. The numbers give the c.p. of A in terms of B. 1. Directly. 2. Rays from A pass through red glass. 3. Rays from A through green glass. 4. Rays from A through violet-blue glass.

	Direct.	Red.	Green.	Violet-blue.
	I.	II.	III.	IV.
W. S. Dennett	4·00	0·520	0·385	0·052
Author	4·00	0·480	0·385	0·048
J. T.	4·94	0·101	0·683	0·235
J. T., using ordinary wedge photometer	5·00	0·11	0·72	0·23

In the following table the percentage of visible light transmitted by each of the three glasses was calculated by means of the above table for the different observers :—

	Red.	Green.	Violet-blue.
W. S. Dennett	13·0	9·62	1·30
Author	12·0	9·62	1·20
J. T.	2·04	13·8	4·75
J. T., using ordinary wedge photometer	2·2	14·4	4·6
Standard Eye	13·7	9·62	1·39

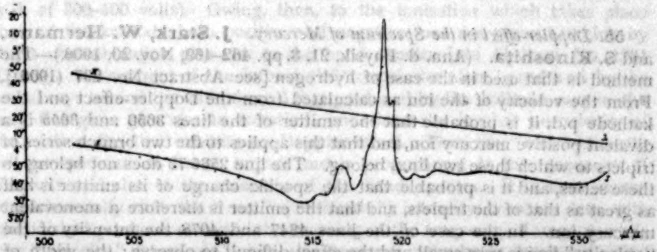
The standard for normal vision adopted was that defined by Rood, namely, the mean colour vision of eleven persons possessing, according to ordinary tests, normal vision. This standard is indicated by 100 in the case of red, green, and violet-blue. One hundred was taken as the maximum attainable by any person in each case, as the experiments did not deal with the general sensitiveness of the eye to light, but with its relative sensitiveness to light of different colours. In the case of each person the highest ordinate of the colour curve is set equal to 100, the others being drawn to scale on this assumption. Both W. S. Dennett and the author had their colour vision expressed in terms of this standard by O. N. Rood. The results given in the first two rows of the following table are taken from Rood's paper (ref. *quo ante*) :—

	Red.	Green.	Violet-blue.
W. S. Dennett	93·8	100	91·5
Author	89·9	100	87·8
J. T.	4·84	45·2	100·0

From these tables the numbers given above for the percentage light received from a glow-lamp by a "standard eye" after passing through red, green, and violet-blue glass were computed. The colour curve for J. T. had the highest ordinate in the violet-blue; this was therefore called 100. It was found that J. T. could compare lights of different colours with the ordinary photometer with the same ease that a person with normal vision can make the comparison by the flicker photometer. The spectrum of an incandescent lamp seemed to J. T. to extend from 6850 A.U. in the red to 4000 in the violet, while to the author the same spectrum seemed to extend from 7700 to 3800. The position of maximum luminosity for J. T. was near the wave-length 5250, while for the author it was 5800. A. R.

50. *Stroboscopic Phenomenon with Vibrating Tuning-forks.* **E. Wagner.** (Ann. d. Physik, 21. 3. pp. 574–582, Nov. 20, 1906. Phys. Inst. d. Univ., München, July, 1906.)—Explains by photographs and diagrams the superposition of a uniform translation and an oscillation such that when the two motions are in opposite directions a state of apparent rest is obtained giving brightness of the image, which in turn becomes invisible when the two motions are in the same direction and so have a large resultant. E. H. B.

51. *Anomalous Dispersion of Magnetic Rotation.* **G. J. Elias.** (Phys. Zeitschr. 7. pp. 981–983, Dec. 15, 1906.)—In view of the uncertainty as to the course of the above effect in the neighbourhood of an absorption band [see Abstracts Nos. 1791 (1900), 465, 2039 (1902), 54 (1903), 69 and 808 (1904), 1880 (1905)], a thorough investigation of the question is undertaken, and in this preliminary communication the curve shown gives the doubled magnetic rotation observed in a solution of erbium chloride in a field of 7,500 for a band in the green near λ520. The ordinates give rotations and the abscissæ wave-lengths, and the plain curve gives the effect for water. G. E. A.



52. *The Shifting of Lines in the Spectra of Calcium, Tin, and Zinc.* **F. Exner** and **E. Haschek.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 523–545, May, 1906.)—The authors have previously noticed that the wave-lengths of lines in the spectra of certain metals showed variations according to whether the metal in question was pure or only an impurity in another metal. They attributed this shift to the same class of phenomena as observed by Humphreys and Mohler, but considered the effect to be due to the partial pressure of the vapour of the metal. This view has met with considerable opposition, and in the present paper they give measurements of certain lines in the spectra of Ca, Sn, and Zn, the spectra being obtained in different ways. For example, in the case of Zn they use a solution of $ZnCl_2$, also brass and zinc as electrodes, thus obtaining three different partial pressures of Zn vapour. The shifts are considerable, amounting to as much as 0·1 A.U. The authors conclude that their original suggestion has been amply confirmed. Full details of the measurements are given.

E. C. C. B.

53. *Influence of a very Strong Magnetic Field on the Spark Spectra of Palladium, Rhodium, and Ruthenium.* **J. E. Purvis.** (Cambridge Phil. Soc., Proc. 13. pp. 325–353, Nov. 5, 1906.)—This paper contains measurements of the resolved lines in the spark spectra of Pd, Rh, and Ru, as observed in a magnetic field of 39,980 units. Certain regularities may be observed on comparison of the lines of the three metals as regards the polarisation and the value of $d\lambda/\lambda^2$. Further, the displacements of the constituents of some of the resolved lines are simple multiples of one another; again, the value of $d\lambda/\lambda^2$ for the constituents of some lines is a multiple of the value for the constituents of other lines. E. C. C. B.

54. *Experiments on the Band-spectrum of Nitrogen in a Strong Magnetic Field.* **J. E. Purvis.** (Cambridge Phil. Soc., Proc. 13. pp. 354–355, Nov. 5, 1906.)—The author has repeated Becquerel and Deslandres' experiments upon the band-spectrum of nitrogen in a magnetic field of 41,000 units and confirms their result, namely, that there is no appreciable widening or resolution of the bands. A 21-ft. focus grating was employed. It thus appears that the vibrations producing the band-spectrum are different from those producing a spark-spectrum. E. C. C. B.

55. *Doppler-effect in the Spectrum of Mercury.* **J. Stark, W. Hermann,** and **S. Kinoshita.** (Ann. d. Physik, 21. 3. pp. 462–469, Nov. 20, 1906.)—The method is that used in the case of hydrogen [see Abstract No. 297 (1906)]. From the velocity of the ion as calculated from the Doppler-effect and the kathode p.d. it is probable that the emitter of the lines 3650 and 3655 is a divalent positive mercury ion, and that this applies to the two branch series of triplets to which these two lines belong. The line 2536·72 does not belong to these series, and it is probable that the specific charge of its emitter is half as great as that of the triplets, and that the emitter is therefore a monovalent mercury ion. In the case of the lines 4347 and 4078 the intensity of the "velocity" line is very small and the effect difficult to observe; the width of the intensity minimum is great. Owing to the uncertainty of the observations, it is difficult to determine the specific charge, but it is possible that the emitter is a trivalent ion. S. G. S.

56. *Ultra-violet Doublets of Zinc, Cadmium, and Mercury; and Thermal Heterogeneous Radiation.* **J. Stark** and **S. Kinoshita.** (Ann. d. Physik, 21. 3. pp. 470–482, Nov. 20, 1906.)—The homology of the ultra-violet doublets of Zn, Hg, and Cd is established by showing that the distribution of intensity between the components of a member of a series is independent of the method of exciting the substance to radiation. Three different temperatures are employed—the arc at low pressure and low temperature, the arc in air at high temperature, and the spark discharge. Incidentally, several new mercury lines were discovered. Further, the lines 2536 of Hg, 2288 of Cd, and 2138 of Zn are components of doublets of which the other components are 2099·5 for Cd and 2166·5 for Zn. In the second part it pointed out that the radiation from the arc is exceedingly complex, owing to the difference of temperature of the different layers, and that great difficulty exists in interpreting the results; in other words, the radiation is heterogeneous as regards temperature. S. G. S.

57. *Emission of Light from the Canal Rays in Hydrogen.* **J. Stark.** (Ann. d. Physik, 21. 3. pp. 401–456, Nov. 20, 1906.)—Previous work by the

author and others is reviewed and certain new experiments are described. The paper is in three sections, the first dealing with the emitters of the line spectra, the second with the relation between velocity of translation and intensity of radiation, and the third with the relation between velocity and wave-length. The identity of the emitter of the line spectra with the positively-charged "remainder atom" (Restatom) has been established in previous papers [Abstracts Nos. 1210 (1905), 297, and 541 (1906)]; the author now gives a description of the Doppler-effect in hydrogen with diagrams showing the distribution of intensity due to reflection and dispersion of the canal rays, and from the fact that the Doppler-effect is constant for all the lines of any one series of an element deduces that all the lines of a series are emitted by the same body. From the velocity corresponding to the effect it appears that the emitters of all three series of the hydrogen spectrum are monovalent ions, while the two branch series of triplets of mercury are emitted by a divalent atom; and in general, monovalent ions emit series of doublets; divalent ions, triplets, and the ions of higher valency emit members of series which possess more components the higher the valency. Two experiments are given, in which it is shown that the canal rays cannot cause ionisation if their velocity is under a certain limit (that produced by a p.d. of 800–500 volts). Owing, then, to the ionisation which takes place behind the kathode, both positive and negative ions are present, which by their recombination give rise to the band spectra [see Abstract No. 1281 (1906)]. On account of the impact, the "remainder atom" produced by the canal rays behind the kathode and that produced by the kathode rays in the negative glow give rise to radiation; and since the ion has no velocity of translation, the line exhibits no Doppler-effect. Thus the "rest" intensity of the spectrum is due to impact and is proportional to the frequency of impacts and also to the intensity of the band spectra. It is then shown experimentally that the "rest" ("ruhende") intensity becomes less with diminished pressure, owing to the lessening of the frequency of impact, while the "velocity" ("bewegte") intensity does not; the latter increases owing to the greater velocity (on account of increased kathodic p.d.), the radiation in this case being analogous to temperature radiation. Further, the distribution of intensity in the case of the lines of the same member of a series is the same, and is a function of the method of excitation (canal-ray velocity or temperature). The width of the intensity minimum in a given series increases with decreasing wave-length. With increasing velocity of the rays the maximum of intensity moves towards the lines of shorter wave-length—an effect which is analogous to the distribution of intensity in the case of the radiation from a perfectly black body. If the radiation from the arc and spark discharge are temperature radiations and the temperature of the spark higher than the arc, the intensity maximum within a series should be nearer the ultra-violet in the case of the spark than in that of the arc. By considering the work of several authors this is found to be the case. The widening of the line in the direction of the red [see Abstract No. 885 (1906)] is redetermined, precautions being taken to eliminate the Doppler-effect. The displacement towards the red with kathode p.d. 4,200 and 7,500 volts is found to be 0·93 and 0·71 A.U. for H_β and 0·17 and 0·42 A.U. for H_γ. A similar displacement towards the red is to be expected in the radiation from the arc owing to the high temperature, *i.e.*, velocity of translation. S. G. S.

58. *Doppler-effect in Canal Rays.* **F. Paschen.** (Phys. Zeitschr. 7. p. 924, Dec. 15, 1906.)—B. Strasser and M. Wien failed to observe the Doppler-effect

due to moving ions in front of the kathode [see Abstract No. 2086 (1906)]; the author has obtained the effect by using a kathode which has no holes bored in it. The light falls upon the slit of the spectroscope in a direction at right angles to the plane of the kathode, the kathode rays travelling towards the slit. With pure mercury-free hydrogen, a dark space of 4 cm. and a voltage of 8,000, a band displaced towards the red is observed in the case of H_β and H_γ, which is separated from the "rest" position by a dark space. On the blue side there is also a Doppler line which may be produced by reflection of the canal rays by the kathode or by the light being reflected by the polished surface of the kathode. The line on the blue side is fainter than that on the red. S. G. S.

59. *Photographic Inactivity of Ammonium Amalgam.* **G. Baborovský** and **V. Vojtěch.** (Phys. Zeitschr. 7. p. 846, Nov. 15, 1906.)—According to A. Coehn [see Abstract No. 1151 (1906)], there should be an emission of electrons when the metal ammonium dissociates to ammonia and hydrogen. The authors have endeavoured to detect these electrons by means of their action upon a photographic plate placed close to the amalgam, allowing an exposure of 24 hours. Two series of observations were made, in one of which the amalgam is prepared electrolytically according to Coehn, and in the other chemically, by the action of a freshly prepared sodium amalgam upon a 20 per cent. solution of ammonium chloride. In no case could the presence of the electrons be detected, even when an electric field is employed with the object of concentrating them upon the plate. S. G. S.

60. *Spectrum of Luminescence of Radium Bromide.* **F. Himstedt** and **G. Meyer.** (Phys. Zeitschr. 7. pp. 762–763; Discussion, pp. 763–764, Nov. 1, 1906. Paper read before the 78 Naturforscherversamml. Stuttgart, Sept. 16–22, 1906.)—Three crystals of radium bromide were attached to the slit of a quartz spectrograph, and exposures of 7 to 10 days were made after filling the collimator with various gases, such as CO_2, CO, H, air, and He. The nitrogen spectrum was used for comparison. The photographs show three continuous bands, each due to one of the crystals. In addition to these bands, the photographs taken with nitrogen and helium show narrow bands traversing the whole plate, including the spaces between the continuous spectra. This shows that the radium bromide excites the characteristic luminous vibrations of these two gases. In helium there are three lines, the strongest of which has a wave-length about 408 in the violet. The authors believe the α-rays emitted by the preparation excite this luminescence, but have no such effect upon H, CO_2, or CO. In the *discussion*, **Stark** expressed his conviction that H, CO_2, and CO also emit their band spectra on recombination after ionisation, and that these would be shown up after longer exposures. **Runge** pointed out that the line 408 by itself does not prove the presence of a helium spectrum. **Marx** claimed that the luminosity is not necessarily due to α-rays, but may be due to the slow β-rays (electrons) described by J. J. Thomson and Rutherford. These have great ionising power. **G. Meyer** replied that he had examined hydrogen in contact with radium with an exposure of 20 days without getting a hydrogen spectrum. The fact that the luminosity extends for 5 mm. beyond the radium crystal tells in favour of α-rays as its cause. E. E. F.

61. *Velocity of Röntgen Rays.* **E. Marx.** (K. Sächs. Akad. d. Wissensch. Abh. 29. p. 443 *et seq.* Ann. d. Physik, 20. 4. pp. 677–722, July 20, 1906.)—The

full experimental results corresponding to Abstract No. 92 (1906). The arithmetic mean of the individual observations gives as the velocity of Röntgen rays the value for the velocity of light with a divergence of 0·5 per cent. As this divergence is less than the experimental error, it follows that the velocity of the Röntgen rays is the same as the velocity of light, with a probable error of about ± 1 per cent. L. H. W.

62. *Absorption of α-rays by Aluminium.* **S. Meyer** and **E. v. Schweidler.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 718–788, May, 1906. From the Inst. f. theoret. Physik u. dem II. phys. Inst. der k.k. Univ., Wien.)—By an electroscope method the absorption by aluminium of the radiation from uranium (freed from UrX), RaF, AcB, ThB, RaC is investigated. Using comparatively great thicknesses the absorption for β-rays is found, and hence by extrapolation the intensity and also the absorption for α-rays. The extinction thicknesses for the latter are, in 10^{-4} cm., Ur = 10, RaF = 28, AcB = 82, ThB = 40, RaC = 45, or taking McClung's and Hahn's value for the relative absorbing power of Al and air, viz., 10^{-4} cm. Al is equivalent to 0·16 cm. air, the ranges in air, in the same order as before, are 1·6, 4·5, 5·1, 6·4, 7·2 cm. The authors do not get the maximum in the ionisation found by Bragg and others at different distances, except for ThB and RaC. They therefore conclude that the absorption in metals and air are brought about by different mechanisms, and they advance a theory intended to account for this. R. S. W.

63. *Absorption of α-rays in Metals.* **E. Meyer.** (Deutsch. Phys. Gesell., Verh. 8. 22. pp. 581–589, Nov. 30, 1906. Phys. Inst. d. Univ., Berlin, Oct., 1906. Phys. Zeitschr. 7. pp. 917–920, Dec. 15, 1906. Écl. Électr. 50. pp. 56–57, Jan. 12, 1907.)—Bragg has shown that the ionisation produced by α-rays is inversely proportional to $\sqrt{1{\cdot}33 + r}$, where r is the distance from the end of their range [Abstract No. 544 (1906)]; Rutherford has further shown that the velocity is given by $\sqrt{1{\cdot}25 + r}$ [Abstracts Nos. 1881 (1905) and 1871 (1906)]. Combining these results it follows from the similarity of the constants that the ionisation in a volume element is inversely proportional to the velocity. If absorption and ionisation are proportional to each other, then the former is also inversely as the velocity. This accounts for the fact that the absorption of the radiation by two plates, one of aluminium, the other of tin-foil, is different according to which it passes through first; and it is not necessary to suppose the observed irregularities are caused by diffuse reflection or secondary radiations. The author then shows how, on the above theory, the calculated and observed absorptions agree. The rays from a plate rendered active by RaF are shot into a cylindrical condenser some cm. away, the ionisation produced there is measured for different distances from the source and a curve (A) is plotted. Another curve (B) is obtained giving the absorption produced when a thin aluminium sheet is placed at different distances from the source. Suppose it is now required to calculate the absorption produced by two aluminium sheets at a distance c from the active plate. Curve B gives the absorption produced by the first plate at this distance, and A the equivalent air-path necessary to produce this absorption. Let this path be d. B gives the absorption produced by a plate at distance d, and hence the absorption due to the second plate. Calculation and experiment agree excellently, both in this case and also for a sheet of tin-foil backed by one of aluminium. The absorption in metals would, therefore, seem to be of the same nature as that in gases. R. S. W.

64. *Absorption of Radio-active Emanations by Charcoal.* **E. Rutherford.** (Nature, 74. p. 634, Oct. 25, 1906.)—If a slow current of air mixed with the emanation of radium, thorium, or actinium, is passed through a tube filled with charcoal, the issuing gas is completely deprived of emanation. This occurs at ordinary temperatures, and there is no necessity for initial cooling of the charcoal. If a side tube containing a fraction of a gm. of charcoal is attached to a vessel containing the emanation released from several mgm. of radium bromide, in the course of time the emanation is absorbed by the charcoal. It makes no difference whether the charcoal has been initially heated to get rid of the absorbed air or whether it has already absorbed its full quantity. The greater part of the emanation is released by heating the charcoal below a red heat. This property of charcoal of retaining the emanation may be utilised when radium is to be kept in a state of solution. It is dangerous to keep radium in the form of solution in sealed vessels, as the gradual production of hydrogen and oxygen in the solution raises the internal pressure and may cause bursting of the vessel. By the use of a small tube containing cocoa-nut charcoal attached to the vessel with one end open to the air, the air inside the radium vessel is kept at atmospheric pressure, while the emanation is completely stopped in the charcoal, and can be obtained from this at any time by heating. **J. Dewar.** (Ibid. 75. pp. 6–7, Nov. 1, 1906.)—Dewar calls attention to the fact that it is not the case that the inert gases belonging to the argon family are less liable to absorption by charcoal than ordinary gases, as was supposed by Rutherford. Thus it is not surprising that the emanation of radium, thorium, and actinium should be absorbed by charcoal, but just what might be anticipated from Dewar's previous experiments. With regard to the temperature at which absorption by charcoal takes place; on comparing the behaviour of carbonic acid and recalling that Rutherford and Soddy found that cooling below 188° abs. was necessary to condense the radium emanation, analogy would indicate that at twice 188° abs. (or about the ordinary temperature) charcoal would still act as a condensating agent. Rutherford and Soddy's results would seem to indicate that the radium emanation has a high latent heat of volatility, and consequently by all analogy a high boiling-point. J. J. S.

65. *Radio-activity of the Eruption Products of Vesuvius.* **R. Nasini** and **M. G. Levi.** (Accad. Lincei, Atti, 15. pp. 391–397, Oct. 7, 1906.)—A mass of 125 gm. of each specimen is finely powdered and dried and placed in the dispersion apparatus. The saturation current in amps. and the potential drop in volts per hour are both given. The greatest radio-activity is found to belong to the sands and lapilli, the specimens taken having been deposited upon the roof of the observatory; the greatest saturation current is $33{\cdot}5 \times 10^{-15}$ amp. and potential-fall 7·5 volts per hour. The scoria and other solidified lavas were found to be inactive. For products from the 1872 eruption the sands and lapilli reach current $19{\cdot}2 \times 10^{-15}$ amp. and the lavas 13×10^{-15}. For lavas from the eruptions of 1631, 1767, 1858, 1868, and 1895–99, the corresponding saturation currents are 17, 19·7, 14·7, 28·2, and 4·9, all $\times 10^{-15}$ amp. The results show that the lava which is inactive immediately after solidification, acquires radio-activity slowly as time elapses. S. G. S.

66. *Energy of Radium Radiation.* **J. Precht.** (Phys. Zeitschr. 7. p. 836, Nov. 8, 1906. Paper read before the 78 Naturforscherversamml. Stuttgart. Ann. d. Physik, 21. 3. pp. 595–601, Nov. 20, 1906.)—Measurements taken with precautions guaranteeing an accuracy to within 1 per cent., show that radium

bromide free from water of crystallisation yields a quantity of heat equal to 122·2 cals. per gm. per hour. This quantity is increased to a maximum of 184·4 cals. by cutting off the β-rays by means of a lead screen 3 mm. thick. The total mass of β-rays (electrons) projected per gm. per hour is $1·6 \times 10^{-12}$ gm., assuming their mean velocity to be $2·5 \times 10^{-10}$ cm. per sec. E. E. F.

67. *Decay of Radium A B and C.* **H. W. Schmidt.** (Ann. d. Physik, 21. 4. pp. 609–664, Nov. 27, 1906. Phys. Inst. d. Univ., Giessen, Aug. 29, 1906. Écl. Électr. 50. pp. 88–90, Jan. 19, 1907 *et seq.*)—In a previous work the author was led to the conclusion that the transformation from radium B to radium C is accompanied by the emission of rays [see Abstract No. 804 (1906)], and the present work is undertaken with the object of investigating the nature of these rays. The active material is deposited upon thin sheets of copper, brass, or aluminium, and aluminium sheets of various thicknesses are placed between the active layer and the dispersion vessel; the following are some of the conclusions reached: (*a*) Radium A alone is deposited from the emanation, and from it radium B and radium C are successively formed. (*b*) Equations can be obtained from Rutherford's theory of decay [see Rutherford's "Radio-activity," 2nd ed., chap. ix., 1905] for the formation and decay of these substances, which can be experimentally verified for various times of activation and thickness of absorbing layer. (*c*) The α-rays of radium A and radium C suddenly lose their ionising effect for a given thickness of absorbing layer. (*d*) The radiation effect of radium B can be explained on the supposition that there are three groups of rays each of which is absorbed according to an exponential law, and in the case of the β-rays of radium C two groups, the relative absorption coefficients for Al being in the case of radium B rays, 890 cm.$^{-1}$, 80 cm.$^{-1}$, and 13·1 cm.$^{-1}$, and in the case of radium C, 53 cm.$^{-1}$, and 13·1 cm.$^{-1}$. (*e*) The rays of radium B of absorption-coefficient 80 are β-rays which are more strongly deflected by a magnetic field than the β-rays of radium C. (*f*) The exponential law for the absorption of the different groups of β-rays may be explained on the hypothesis that in passing through an absorbing solid substance a definite percentage of the rays are stopped, by absorption or deviation, while the remainder may pass through unaffected. S. G. S.

68. *Production of Radium from Actinium.* **B. B. Boltwood.** (Nature, 75. p. 54, Nov. 15, 1906. Amer. Journ. Sci. 22. pp. 537–538, Dec., 1906. Phys. Zeitschr. 7. pp. 915–916, Dec. 15, 1906. Translation.)—The author has shown that, starting with a solution of uranium nitrate carefully purified, the amount of radium formed in eighteen months is less than $\frac{1}{1000}$th part of that to be expected from the disintegration theory. This, he thinks, may be explained by actinium being a product intermediate between radium and uranium, so that the production of radium is proportional to the actinium present. In support of this the following experiment is given: 1 kg. of carnotite is treated so as to separate from it all the actinium, and the solution containing the latter is sealed in a glass bulb. About two months later the emanation is boiled off and tested. The activity corresponds to a content of $5·7 \times 10^{-9}$ gm. of radium in the solution. After an interval of over six months the gas is again boiled off and the radium content is now $14·2 \times 10^{-9}$ gm. In 193 days $8·5 \times 10^{-9}$ gm. of radium have been produced. This gives $\lambda(\text{year})^{-1}$ for radium as $2·2 \times 10^{-4}$. The half-value period is about 3,100 years. It is noteworthy that the amount of actinium in a mineral is apparently always proportional to the amounts of uranium and radium. R. S. W.

69. *Some Peculiarities of Actinium.* **M. Levin.** (Phys. Zeitschr. 7. pp. 812–815, Nov. 8, 1906. Écl. Électr. 49. pp. 463–464, Dec. 22, 1906.)—The temperature of volatilisation of the active products of disintegration of actinium was investigated. A platinum wire was made active; charged negatively it was exposed many hours to the emanation so that the disintegration products attained the equilibrium condition. Afterwards the activity of the wire was measured, and then it was heated in an electric oven at a known temperature. The temperature was measured by means of a Barnes platinum-wire pyrometer. The observed results show that actinium A is not volatile below 400° C. Above this temperature volatilisation commences and increases with rise of temperature, but not proportionally to this. At 750° practically all the actinium A had evaporated in 10 min. The temperature of volatilisation of actinium B lies about 700°. This temperature could not be determined with the same accuracy as in the case of actinium A. Miss Brooks found [Abstract No. 8201 (1904) and Phil. Mag., Sept., 1904] that if a salt solution of the active deposit of actinium is electrolysed, actinium B is set free at the kathode. Experiment shows that a similar result is obtained with an acid solution of actinium X. The period of actinium B is about 0·0015 day, whilst that of actinium X is about 10·2 days. Various experimental observations of the author and of other observers relating to the products of thorium, polonium, and radium, as well as those of actinium, are given in the paper. J. J. S.

70. *Diffusion of Thorium X.* **G. Hoffmann.** (Ann. d. Physik, 21. 2. pp. 239–269, Nov. 8, 1906. From Inaug. Dissertation, Bonn.)—With a view to extending the knowledge of the peculiarities of the short-lived radio-active transformation products, the author has investigated the diffusion of thorium X in water, and has determined the diffusion-coefficient. The method of observation was first made use of by H. F. Weber. The time change of concentration of two solutions of different strength is observed at their surface of separation. The salt solution is placed in a vertical cylindrical vessel: the concentration of the salt (γ) should only vary in a vertical direction. Let x be the distance of a point from the bottom of the vessel, the concentration γ is expressed as $\gamma = \phi(x)$. If, according to Fick, the mass of salt passing per sec. through 1 sq. cm. is taken as proportional to the fall of concentration, then the equation $d\gamma/dt = kd^2\gamma/dx^2$ holds true, in which the constant k is the diffusion-coefficient. The various observations made are described in detail, and tables of the values obtained are given. From these a general expression is deduced. Thorium X behaves in diffusing like a simple substance. Reducing the values of the diffusion-constant at different temperatures to that for a mean value, according to the formula given by Nernst for a fully dissociated salt, viz., $k_t = k_{10}[1 + 0{\cdot}033(t - 10)]$, the value of the diffusion-coefficient of thorium X at a temperature of 10° C. is arrived at. This is: $K_{10} = 0{\cdot}504 \pm 0{\cdot}015$. J. J. S.

71. *Active Components of Radio-lead.* **S. Meyer** and **E. v. Schweidler.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 697–711, May, 1906. From the Inst. f. theoret. Physik u. dem II. phys. Inst. d. k.k. Univ., Wien.)—Rutherford has found for the time to fall to half-value 4·5 days for RaE, but for the corresponding time of rise 6 days. The authors seek to account for this discrepancy. Active lead chloride is converted to the acetate and dissolved in water, then, using platinum electrodes, currents of different intensities are sent through and the activity of the kathode tested by an electroscope in the usual way. With a current density of 4×10^{-6} amp. per cm.^{2}, RaF is alone deposited; with 10^{-5} amp. per cm.^{2}, RaE and RaF; when the density is 10^{-4}, RaD and lead also appear. The decay curves for RaE then show two distinct parts; for one the halving period is 4·8 days, and for the other 6–6·5 days. RaE is therefore not one simple product, but two, which the authors call RaE_1 ($\lambda = 6–6·5$ days) and RaE_2 ($\lambda = 4·8$ days). RaE_1 is rayless, volatile at a red heat, and soluble in hot acetic acid. RaE_2 is not volatile at a red heat, and gives out β-rays; these are approximately homogeneous, and are characterised by an absorption-coefficient 145/cm. for aluminium. They are therefore cut down to half-value by 0·0048 cm. of aluminium. The radium "rest" activity, *i.e.*, the sum

$$RaD + RaE_1 + RaE_2 + RaF,$$

emits in addition a very soft radiation requiring $1·5 \times 10^{-4}$ cm. of Al to cut it down to half. R. S. W.

72. *Separation of Radio-active Substances from Ordinary Lead.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 7. pp. 841–844, Nov. 15, 1906.)—In pursuing the question of the intrinsic radio-activity of lead [see Abstracts Nos. 1219 and 1221 (1905)] the authors have attempted to chemically separate radio-active substances from lead. A mass of 1 kg. of pitchblende which shows marked radio-activity is treated by the method of J. Danysz [see Abstract No. 1729 (1906)], with the object of separating the rayless radium D from radium E and F, should these be present, by means of fractional crystallisation. The part corresponding to the latter shows increased radio-activity, while that corresponding to radium D shows no activity. One kg. of chemically-pure lead nitrate is then treated in a similar manner; and the same result is obtained. In order to see whether this radio-activity is caused by the presence of radio-active substances in the laboratory, control experiments are performed, in one of which iron is substituted for lead. In this case there is no activity. The authors incline to the possibility of the activity of lead being due to the long-lived products of radium, but consider that the possibility of it being due to a product of lead corresponding to UrX is still an open one. Experiments on greater quantities of lead, and on lead of much greater age, are necessary to settle the question. S. G. S.

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73. *Intensification of the Doppler-effect.* **H. C. Richards.** (Science, 24. pp. 466–467, Oct. 12, 1906.)—A criticism of Heyl's suggestion [Abstract No. 1728 (1906)]. It is pointed out that there is a fallacy in considering a moving image to be in all respects equivalent to a moving object. G. E. A.

74. *Spectra Photographed with the Tele-objective.* **M. Wien** and **J. Zenneck.** (Deutsch. Phys. Gesell., Verh. 8. 20. pp. 494–496, Oct. 30, 1906. Paper read before the 78 Naturforscherversamml. Stuttgart, Sept. 18, 1906.)—Shows how the expensive long-focus objective may be replaced by the comparatively cheap tele-objective when an increased magnification is desired. Photographic examples are reproduced. L. H. W.

75. *Chemical Reactivity of the Carbonyl Group as measured by its Absorption Spectrum.* **A. W. Stewart** and **E. C. C. Baly.** (Astrophys. Journ. 24. pp. 95–110, Sept., 1906.)—Largely a general exposition of recent work on "isorropesis." D. H. J.

HEAT.

76. *Raup Gas Calorimeter.* **Lux.** (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1840–1841, Nov. 10, 1906. Paper read before the Pfalz-Saarbrücker Bezirksverein, May 5, 1906.)—This new form of gas calorimeter is based upon the fact that the time required for heat to travel from the point where it is generated to another point at a fixed distance from it, and to raise the temperature of a definite mass at this point through 10° C., varies within fixed limits and depends upon the difference of temperature between the point where the heat is generated and the point where the thermometer is placed. The instrument based upon this principle consists of a gas-burner, a copper cylinder, solid above and hollow below, and a thermometer for registering the heat in the upper portion of the cylinder. By noting accurately the time required to raise the temperature of this cylinder 10° C. when burning the gas in the burner below it, data are obtained for determining the calorific value of the gas. The values obtained are relative and each instrument must be provided with a chart giving the readings obtained for gases the calorific values of which are known, before it can be employed for calorific work. Having obtained fixed points on this chart, showing the relation between time and calorific value, the intermediate values can be obtained by interpolation. For technical work not involving great accuracy, the new form of calorimeter is recommended by the simplicity of its construction, its low cost, and by the speed with which determinations can be made with it. J. B. C. K.

77. *New Method for Calorimetric Valuation of Gases.* **M. Casaubon.** (Journal of Gas Lighting, 95. pp. 41–42, 1906.)—The principle of this method is that of measuring the air required for the complete combustion of the gas, in place of measuring the heat produced by a definite volume of the same. In carrying out the method the gas is burned in a Bunsen burner, to which the air and gas are supplied by separate meters. The flame is surrounded with a mantle of cerium oxide, and the criterion of perfect combustion is the change in colour of this mantle from red to white. It is stated that an infinitely small change in the supply of air suffices to change the red colour caused by a reducing flame, to a white colour, which is the sign of an oxidising flame. A ceria mantle can be obtained by soaking an ordinary mantle in a 80 per cent. solution of cerium nitrate. The new method is stated to yield fairly exact results, the error in the case of a coal-gas enriched with benzene being only 8 cals. per m.^{3}. J. B. C. K.

78. *Demonstration of Boyle's Law.* **H. J. Reiff.** (Deutsch. Phys. Gesell., Verh. 8. 20. pp. 526–527, Oct. 30, 1906. Paper read before the 78 Naturforscherversamml., Stuttgart, Sept. 18, 1906.)—A simple apparatus is described whereby the *pv* curve may be plotted automatically. A vertical screen and the mercury reservoir are attached to holders which slide up and down two parallel uprights so that as one rises the other falls, the velocity ratio being 1 : 4. The air is contained in a capillary tube which is horizontal and lies upon the face of the screen. As the mercury reservoir rises and falls the screen falls and rises, and the path of the mercury meniscus in the capillary tube is the *pv* curve. S. G. S.

79. *Tests of Heat-insulators.* **H. Benisch and A. Andersen.** (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1655–1668, Oct. 13, 1906.)—Describes extensive tests of the heat-insulating efficiency of a series of materials, including kieselguhr, cork, silk, felt, and two forms of special material known as "Kalorit" and "Kalorit Spezial." The tests were made upon tubes insulated with the materials in question and heated internally by means of electric current. The current consumption required to maintain a given temperature and also the temperature attained with a given current were determined, and the results are given in tabular and graphic form; the temperature ranged up to 500° C., but the combustible materials were charred or burnt before this temperature was attained. The coefficients of thermal conductivity are calculated by the author from his tests, on the formula of Péclet, $k = dW/(t - t')$, where d is the thickness of the material used (in this case 5 cm.), W the heat transmitted per hour through a cube of 1 m. side, and t and t' are the temperatures of the two faces. The author's values are given in the following table:—

Silk	$k = 0{\cdot}0563$	Kalorit	$k = 0{\cdot}0697$
Felt	$k = 0{\cdot}0606$	Kork	$k = 0{\cdot}0794$
"Kalorit Spezial"	$k = 0{\cdot}0620$	Kieselguhr	$k = 0{\cdot}1065$

In comparing these values, however, it should be borne in mind that while silk fails, through carbonisation near 270°, "Kalorit" has stood up to 550°.

W. Ros.

80. *Measurements of Temperature up to 1,600° C. with the Nitrogen Thermometer and with the Spectrophotometer.* **L. Holborn and S. Valentiner.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 44. pp. 811–817, 1906. Communication from the Physikal.-Techn. Reichsanstalt.)—Constant volume observations were made on nitrogen contained in an iridium vessel, of volume 54·3 c.cm. at 0°, heated in an electrical stove with its heating tube of iridium. The pressure employed did not exceed 24 cm. at 0°, so that no deformation of the tube should occur at higher temperatures. In order to prevent contact of the thermo-element with the walls of the stove, which at the high temperatures employed were more or less electrically conductive, the vessel was hung vertically even though the temperatures of its parts were caused thereby to differ by as much as 60°. The thermo-element used was made of platinum and platinum-rhodium wires placed in a quartz tube, and the formula

$$E = 30000 \log_{10} [1{\cdot}25 + (t/1000)^2] - 1015$$

was found to connect very satisfactorily its e.m.f. in microvolts with nitrogen temperatures, from 795° to 1,676°, with a maximum uncertainty of 10° in the estimation of temperature from the e.m.f. This thermo-element gave 1,575° as the melting-point of palladium—which is the estimate that should now be used in standardisations. In the optical measurement of temperature by estimation of black radiation with a spectrophotometer the constant c in Wien's formula $\log(H/H_0) = (c/\lambda)(T_0^{-1} - T^{-1})$, where H is the brightness at absolute temperature T of radiation of wave-length λ, is now found to be 14,200, the higher value given by previous observers being due to extrapolation in their estimation of temperature.

R. E. B.

81. *Baths of Constant and Uniform Temperature by means of Liquid Hydrogen.* **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Versl. 15.

pp. 109–133, July 20, 1906. Proc. 9. pp. 156–180, Oct. 25, 1906. Communication No. 94 f. Phys. Lab. Leiden.)—The author describes in detail the latest additions to the cryogenic laboratory for the purpose of obtaining accurate measurements in liquid hydrogen especially between the temperatures − 252° C. and − 259° C. The cascade method which has been used for former steps is not sufficient here alone, but has to be combined with the regenerative principle. As now employed, the hydrogen liquefier is cooled by liquid air prepared as formerly, the hydrogen being usually admitted at about 180 atmos. pressure, although 70 atmos. is just sufficient. The regenerator tube is contained in a vacuum glass as first employed by Dewar, and under these conditions delivers about 4 litres of liquid hydrogen per hour. The gas used for accurate measurements is purified by careful distillation from the liquid, the first operation reducing the impurities to about 0·05 per cent.; and owing to the elaborate precautions to prevent leakage the hydrogen remains very pure. For these experiments a new cryostat is used, which is specially designed and allows of very constant and uniform temperatures being obtained. In one experiment 8 litres of air were used for the preliminary cooling, and then the introduction of 5 litres of hydrogen left 1·5 litres in the cryostat. When full about 0·2 litre evaporates per hour, and about the same amount during the reduction to 60 mm. pressure. It is not practically possible to much further reduce the temperature with this apparatus, as at 54 mm. pressure solid hydrogen begins to deposit and commences to clog the apparatus.

H. H. F. H.

82. *Inversion Temperature for Air.* **O. Lummer.** (Phys. Zeitschr. 7. pp. 864–865, Nov. 15, 1906.)—The occurrence of a temperature of inversion is ascribed to ionisation on the encounter of molecules with large speeds whereby an electrical repulsion between the ions is superposed upon their gravitative action, neutralising it at the inversion-temperature and exceeding it at higher temperatures. On this view the molecular speed at the inversion-temperature of air should be of about the same magnitude as that of hydrogen at its inversion-temperature, − 80° C. Lummer takes the speed to vary as the absolute temperature, and thus deduces $(273 - 80)/\sqrt{0{\cdot}0693} - 273 \equiv 460°$ C. for the inversion-temperature of air (0·0693 being the sp. gr. of H relatively to air), which lies between the estimates of Witkowski (500°) and Rose Innes (860°). [But on the kinetic theory of gases the molecular speed varies as the *square root* of the absolute temperature, which on this theory would give 2,514° C. for the inversion-temperature of air.] (Ibid. 8. pp. 53–54, Jan. 15, 1907.) Lummer corrects his first results, but arrives at the value 2,840° C.

R. E. B.

83. *Critical Temperatures.* **M. W. Travers** and **F. L. Usher.** (Roy. Soc., Proc. Ser. A. 78. pp. 247–261, Nov. 5, 1906. Zeitschr. Phys. Chem. 57. pp. 365–381, Dec. 11, 1906. Translation.)—Experiments with ether, CS$_2$, and SO$_2$, carefully purified and enclosed in comparatively large mass in thin-walled glass tubes of 8 to 10 mm. internal diam., support the conclusion that the temperature of disappearance of the meniscus separating the two phases is not a function of the relative masses of the coexisting phases at the moment of disappearance (de Heen's theory) and that it is not markedly influenced by a time-factor (Traube's theory). Altschul's observation of the formation of an opalescent band is confirmed: this is brown by transmitted light and whitish by reflected light, and it persists over a finite range of temperature, 0·2° in the case of SO$_2$, 2° in the case of ether. It is formed below

the surface if the meniscus is near the bottom of the tube when near disappearance, and it is the more intense the nearer the meniscus is to the bottom of the tube : it is, on the contrary, formed above the surface if the disappearing meniscus is near the top of the tube, and the intensity increases with the nearness ; if during the last stages of heating the meniscus remains stationary, being then about the middle of the tube, the tube appears slightly and evenly opalescent throughout its whole length, as indeed happens in the other two cases after the disappearance of the meniscus if sufficient time is allowed to elapse or if the contents of the tube are stirred by an iron stirrer operated by a magnet. In the first two cases the opalescence on first making its appearance was most intense immediately above or below the meniscus, but very rapidly diffused through the phase in which it was formed. An explanation of the phenomenon of this opalescent band, and more especially of its confinement to the phase which is decreasing in volume owing to the motion of the meniscus, is deduced from Donnan's suggestion of variation with curvature of the interfacial surface-tension at the critical temperature. [See also next Abstract.] R. E. B.

84. *Opalescence in Fluids near the Critical Temperature.* **S. Young.** (Roy. Soc., Proc. Ser. A. 78. pp. 262–263, Nov. 5, 1906. Chem. News, 94. p. 149, Sept. 28, 1906.)—Opalescence is observed even in tubes of 0·15 mm. internal diam. In Travers and Usher's experiments [see preceding Abstract] the total volume of the fluid investigated remained constant while the temperature rose very slowly ; when, however, the fluid is kept at the critical temperature and its volume is decreased by equal stages, opalescence begins to appear at the bottom of the tube when the volume reaches a definite limit, and it becomes denser and extends upwards as the volume is diminished ; at about the critical volume the mist is very dense near the middle and may extend throughout the tube or leave one or both ends clear ; with further diminution of volume the mist clears below, but becomes dense above, and the mist finally disappears at a definite volume. The limits of volume between which mist is visible at the critical point are 1·175 and 0·875 times the critical volume in the case of the normal pentane, isopentane, hexane, and octane. From these observations it seems that the position of maximum opalescence depends rather on the mean specific volume of the fluid than on the direction of motion of the meniscus. R. E. B.

85. *Vapour Pressure of Liquid Ammonia.* **O. Brill.** (Ann. d. Physik, 21. 1. pp. 170–180, Oct. 25, 1906.)—The vapour tension of solid and liquid ammonia at temperatures between —80° and —33° C. has been measured by a static method ; it varies from 3·52 to 76·1 cm. of mercury. At —79·2° the vapour pressure of solid ammonia was also found as 3·65 cm. of Hg by the dynamic method of passing pure hydrogen, generated electrolytically, through the ammonia and quantitatively analysing the resulting gaseous mixture. The freezing- and boiling-points were found to be —77·7° and —33° C. respectively. The observed values of the vapour-pressure conform satisfactorily to Nernst's theoretical formula—

$$\log p = -\lambda_0/4{\cdot}571\,T + (3{\cdot}5/R)\log T - \epsilon T/2{\cdot}3\,R + C,$$

with the values $\lambda_0 = 6{,}580$, $\epsilon = 0{\cdot}02785$, $C = 3{\cdot}31$. R. E. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

86. *Motion of an Electron under Longitudinal Force.* **P. Hertz.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 3. pp. 229–268, 1906.)—A highly mathematical treatise dealing with the questions—(1) What force is needed to generate a given motion? (2) What motion will a given force generate? The theorem is established that the motion of an electron with given initial conditions and a subsequent prescribed external longitudinal force admits of but one solution. It is further shown that, apart from external forces, no motion can be maintained at a speed exceeding that of light. On the other hand, every periodic motion of period (electron-diameter)/(speed of light), is free from external forces. The paper closes with a list of six points which still remain for consideration and research. [See also Abstract No. 1290 (1906).] E. H. B.

87. *Ratio of Transversal and Longitudinal Masses of Electrons.* **A. Einstein.** (Ann. d. Physik, 21. 3. pp. 583–586, Nov. 20, 1906. Écl. Électr. 49. pp. 493–494, Dec. 29, 1906.)—Describes with a figure a method which might be used to experimentally determine the above ratio of electron masses. It is so arranged that under the influence of a deflecting voltage Π the electrons (of the kathode rays) are deflected in a strongly curved path in which slight differences of the two masses manifest themselves in a marked change of path. According to theory the ratio of the transverse mass T to the longitudinal mass L is given by $T/L = 1 - a\Pi/10000$, where the constant a has the value 0·0070 according to Bucherer, 0·0084 according to Abraham, and 0·0104 according to Lorentz and Einstein. E. H. B.

88. *Electrical Experiment with Table-top.* **W. Holtz.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 3. pp. 273–274, 1906.)—The author rubbed with his hand the polished top of a table to see if it would serve as the cake of an electrophorus, but failed to obtain sparks from it. However, an electroscope showed that an electrification was produced at the time, but one which soon leaked away. It was then discovered that an electroscope could be very conveniently charged by rubbing its knob with the left hand and at the same time rubbing the polished table-top with the right hand.
E. H. B.

89. *Positive Charge under Influence of Ultra-violet Light.* **Mme. Baudeuf.** (Comptes Rendus, 143. pp. 895–897, Dec. 3, 1906.)—The plate P_r to be charged (which may be of any metal) is placed in the neighbourhood of the exciting body P_a, which is charged to a high positive potential. So long as P_r is shielded from the ultra-violet rays its potential is simply due to its proximity to P_a; but if the rays fall on the surface turned towards P_a, then the potential of P_r rises gradually, till at the end of a few minutes it has reached several hundreds, or even thousands of volts, if the potential of P_a is sufficiently high. With P_a connected to the positive pole of a small Wimshurst machine, the potential of P_r rose to over 1,500 volts at a distance of 4 m. The phenomenon cannot be attributed to deposition, nor to convection

of material particles issuing from the electric arc used as a source of light. The author states that the radiations which bring about the phenomenon are ultra-violet rays of very great wave-length, and which are very penetrating. The active rays appear to vary with the metal to be charged. For copper the wave-length is between 0·800 and 0·225 μ. If the potential of the exciting body is kept constant, the potential of the receiving plate at first increases rapidly, then more and more slowly, and at last reaches a max. value, which is maintained as long as the conditions remain constant. This maximum is always a good deal less than that of the exciting body. If P_r is discharged the charge increases up to the same maximum as before and at the same rate. This can be repeated as often as one wishes. The max. value of the potential varies with the distance from P_e. If P_e is insulated it is discharged at the same rate as P_r is charged; but this discharge ceases as soon as P_r has reached its max. potential. The discharge of P_e is also stopped if the ultra-violet light is cut off from P_r by the interposition of a glass screen.

A. W.

90. *Diurnal Variation of Atmospheric Emanation.* **P. H. Dike.** (Terrestrial Magnetism, 11. pp. 125–129, Sept., 1906.)—The author points out that the usual method of keeping a bare wire stretched horizontally at a high negative potential for one or two hours and then observing its effect in discharging a gold-leaf electroscope is somewhat unsatisfactory, since with varying wind conditions the wire will have varying amounts of air brought into its vicinity. In the experiments described, air was drawn steadily by means of a large blower through a wooden pipe, carrying at its mouth a piece of insulated wire-gauze, which was kept charged by means of a small Wimshurst machine. The exposures usually lasted an hour, and the intensity of the radio-activity of the wire was read by means of an electroscope. The curves obtained by plotting the reciprocals of the times of passing over twenty scale divisions as ordinates show marked similarities, and though quite irregular, the general tendency is clearly shown. It is shown still more by compounding the curves for the six long series of observations. Though the number is too small to eliminate all the irregularities, the curve obtained is fairly smooth, and shows a minimum about 6 p.m., after which it rapidly rises to a maximum at 1 a.m., followed by a slight drop, and then comes a second maximum about equal to the first at 4 a.m. The depression between 1 and 4 a.m. is a feature of nearly all the curves, and is not accidental. After 4 a.m. the value drops nearly as rapidly as it rose, but during the afternoon it is irregular, though nearly always low and generally decreasing. Weather conditions were found to have an important influence on the amount of emanation present in the air.

A. W.

91. *Earth-air Current.* **C. T. R. Wilson.** (Cambridge Phil. Soc., Proc. 13. pp. 363–382, Nov. 5, 1906.)—The fact that the earth's surface is negatively charged, and the presence in the atmosphere of free ions indicate that in fine-weather regions there must be a continuous flow of positive electricity from the atmosphere into the ground. A knowledge of the magnitude of this current is required to test the sufficiency of the various theories of atmospheric electricity. This paper contains an account of experiments made to test a method of measurement recently suggested [see Abstract No. 580 (1906)]. An insulated conductor connected to an electrometer is initially at zero potential and under a metal cover. The earth connection is broken and the cover removed, the conductor being thus exposed to the earth's electrical

field. The potential of the conductor is thus raised, but it is at once brought back to zero by means of a compensator. When this adjustment has been made, the charge removed from the electrometer and its connections by the displacement of the compensator is equal and opposite to that held on the exposed part of the conductor when at zero potential by the action of the earth's field. When the compensator has once been standardised its readings measure the charge on the exposed conductor when kept at zero potential; this charge will be the same as if the conductor were earth-connected. If now by means of the compensator the conductor be maintained at zero potential for a few minutes and the cover be then replaced, the new reading of the compensator, when again adjusted to bring the electrometer reading back to its zero, measures the charge which has entered the conductor from the atmosphere in the given time. The ratio of the charge passing per minute into the test-plate from the atmosphere to the charge on the test-plate when earth-connected and exposed to the earth's electric field, both measured by the compensator, may be taken as giving the dissipation constant under conditions of exposure identical with those to which natural earth-connected bodies are exposed. The electroscope used was a special one, and is described in the previous paper. The compensator consisted of a brass tube, kept at a constant negative potential by being connected to a quartz Leyden jar, and forming with an inner concentric rod an air condenser of variable capacity. Most of the experiments described were carried out on the top of Hamildon Hill, near Peebles, N.B., and the weather conditions were very varied; also different substances, such as turf, were placed on the test-plate, and the charge on them and current through them found. The charge was found to vary considerably, the highest value being $32{\cdot}8 \times 10^{-3}$, and the lowest $2{\cdot}45 \times 10^{-3}$ electrostatic units. The mean value was $14{\cdot}7 \times 10^{-3}$. The leak per min. also varied a good deal, the highest rate being $1{\cdot}26 \times 10^{-3}$, the lowest $0{\cdot}15 \times 10^{-3}$, and the mean value $0{\cdot}70 \times 10^{-3}$ electrostatic unit per min. The dissipation factor, *i.e.*, (leak per min.)/(charge), had a mean value of 5·65 per cent., the highest value being 10·6 per cent., and the lowest 0·91 per cent. In the latter part of the paper the author discusses at some length the origin of atmospheric electricity. A. W.

DISCHARGE AND OSCILLATIONS.

92. *Measurement of Ionisation.* **T. Thorkelsson.** (Phys. Zeitschr. 7. pp. 834–835, Nov. 8, 1906.)—The author measures the ionisation in a closed vessel by connecting the dissipation body direct with an electrometer having a single aluminium leaf. The electrometer case is connected with the ionisation vessel, and the dissipation body is charged up to about 200 volts. The edge of the Al leaf is observed in the microscope, and the time noted at which it passes a certain mark. At that instant a battery is inserted between the electrometer case and the ionisation vessel, the negative pole being connected with the electrometer case. The leaf then undergoes a greater deflection, and repasses the mark at another instant. Let the interval between the two instants be t sec. Then the quantity of electricity e lost per sec. is determined if the e.m.f. (v) of the battery and the capacity (c) of the dissipation body with reference to the ionisation vessel are known. For $e = cv/t$. This method is independent of the shape and elasticity of the Al leaf, and of changes in them. Besides, it requires no calibration of the electrometer scale. E. E. F.

93. *Ionisation produced by Hot Platinum in different Gases.* **O. W Richardson.** (Roy. Soc., Phil. Trans. 207. pp. 1–64, Nov. 22, 1906. Roy Soc., Proc. Ser. A. 78. pp. 192–196, Sept. 6, 1906. Abstract.)—The objects of the investigation are to examine the part played by the surrounding gas in the production of ions by hot metals, and to discover, if possible, the mechanism by which the positive ions originate. The apparatus is similar to that used by the author in similar work on several previous occasions. A saturation current is always found to exist. The difficulties of making observations are greatly increased by the presence of hysteretic effects with regard to temperature, pressure, and voltage. Immediately after raising the potential the current is large and then gradually falls. The positive ionisation is greater in oxygen than in other gases; at low pressures (less than 1 mm.) and temperatures below 1,000° C. the current varies as the square root of the pressure; at higher temperatures and low pressures it varies nearly directly as the pressure; while at higher pressures, such as those approaching atmospheric, the current is practically independent of pressure. Results not very different are found in air, nitrogen, and hydrogen. In helium there is a positive ionisation which is a function of the pressure. The ions are not large masses approaching dust particles in size, but are of the same order of magnitude as ions produced by collisions. The ionisation shows a minimum value depending on temperature and pressure, and this is given by a formula similar to that which holds for corpuscular emission, viz., $i = A\theta^{\frac{1}{2}}\epsilon^{-b/\theta}$. The view is adopted that the positive ions are produced by the gas absorbed by the metal, and on the supposition that the number so formed is proportional to the amount of absorbed gas, a formula is developed which agrees fairly with experiment. The positive, but not the negative, ionisation from the outer surface of a hot platinum tube in air is increased when hydrogen is allowed to diffuse outwardly. The negative leak is found to be independent of the pressure of the surrounding gas, but a previous heating in hydrogen causes a greatly increased leak. The author thinks this is due to a surface change it produces in the platinum. R. S. W.

94. *Simultaneous Ionisation by Radium and Röntgen Rays.* **T. Noda.** (Cambridge Phil. Soc., Proc. 13. pp. 356–362, Nov. 5, 1906.)—Experiments were undertaken to see whether the ionisation due to Röntgen rays and different Becquerel rays acting simultaneously is equal to the sum of the ionisations due to the same rays acting separately. The author first combined Röntgen rays and radium rays, then radium and uranium rays, and lastly Röntgen rays and uranium rays. In each case the ionisation was equal to the sum of the ionisations due to the various rays acting separately. E. E. F.

95. *Comparative Observations on the Evolution of Gas from the Kathode in Helium and Argon.* **C. A. Skinner.** (Phil. Mag. 12. pp. 481–488, Nov., 1906.)—In previous papers the author has shown that, during the first few minutes after starting an electric discharge through helium under reduced pressure, hydrogen is evolved from a metallic kathode at a rate determined by Faraday's law [see Abstracts Nos. 1768 and 2086 (1905)]. The present paper deals with Al and Mg electrodes in helium and in argon, and the previous results are confirmed; the amount of hydrogen contained in the magnesium, however, is comparatively small, so that the law does not hold for so long a period. E. C. C. B.

96. *Anode Rays.* **E. Gehrcke and O. Reichenheim.** (Deutsch. Phys. Gesell., Verh. 8. 21. pp. 559–566, Nov. 15, 1906. Communication from the Physikal.-Techn. Reichsanstalt.)—Whilst working with a Wehnelt kathode the authors observed a yellow bundle of rays coming from a speck on the anode; these became suddenly brilliant and then disappeared. This bundle cannot be obtained with a clean anode, it is therefore attributed to impurity. By a specially constructed anode and a Wehnelt kathode, a discharge was sent through a tube from 110 volts in which the appearance is more striking and lasts longer. The anode consists of a cylinder of thin Pt-foil open at one end; in this is placed one of various inorganic salts, generally chlorides. The foil is heated from an accumulator battery, then the bundle of rays is very brilliant; the substance in the meantime shows the line spectrum of its metal. The lines are quite sharp. This stream the authors call "anode rays." If the rays are received in a Faraday cylinder they show a positive charge; this positive charge can also be inferred from their deflection in a magnetic field. **R. S. Willows.** (Nature, 75. p. 178, Dec. 20, 1906.)—Gehrcke and Reichenheim have shown that a stream of positively charged particles is emitted by a hot anode in a vacuum tube [see above]. These particles they call anode rays. The author thinks that if the difference in temperature be allowed for, these results of Gehrcke and Reichenheim, and some obtained by Willows and Garrett on the emission of positive electricity by heated salts [Abstract No. 388 (1905)], are different aspects of the same phenomenon. The experiments on anode rays apparently show that the positive ions come from the metal. R. S. W.

97. *Phenomena in Crookes' Tubes.* **N. T. Bacon.** (Amer. Journ. Sci. 22. pp. 310–312, Oct., 1906.)—The gradual attenuation of the discharges may reasonably be ascribed to increasing vacuum, as it is partly overcome by heating the walls of the tube. Glass, as is known, accumulates on its surface a layer denser than the surrounding atmosphere, and this is even more marked with platinum. This, the author suggests, is due to imperfect elasticity of the molecule in the solid state. Hence the phenomena observed with platinum sponge in a hydrogen atmosphere. The hydrogen is condensed to the point of liquefaction. The hydrogen molecules striking the platinum (and similar effects may occur with the coating of platinum black which is formed inside the Crookes' tube) rebound with diminished kinetic energy. The gas particles finally attain the orbital velocity of the much heavier platinum molecule, and are reduced to the liquid condition. A film of gas is formed on the surface, and equilibrium is attained when impact on the film of platinum of a fresh molecule of H causes liberation of another molecule from its surface. Heating such a film would cause liberation of molecules. The platinum film would have a greater effect than glass on the gases concerned, and the platinum coating would increase the vacuum while heating might thus partially restore the activity of the tube. Other observed peculiarities in a Crookes' tube, such as the emission of peculiar rays from the anode, the author suggests may be accounted for by the resolution of atoms into electrons. J. J. S.

98. *Spark Potentials in Liquids.* **R. F. Earhart.** (Phys. Rev. 23. pp. 358–369, Nov., 1906. Electrician, 58. pp. 420–421, Dec. 28, 1906.)—The dielectric liquids are kerosene, paraffin oil, olive oil, and transformer oil. One discharge surface is 3 8 cm. and plane; the other is a ball 2·54 cm.

diam. Both surfaces are of steel. Temperature 21° C. P.d.'s are obtained from a bank of glow-lamps in series. A transformer takes current from a 110-volt 60-cycle circuit, and steps it up to 2,200 volts. In other details the method is similar to the author's researches on sparking in air [Abstract No. 514 (1901)]. A research on the subject has recently been published by Shaw [see Abstract No. 1898 (1906)], but the conditions are different, and results therefore cannot be readily compared. The conclusions are: (1) The potential gradient for very small distances is higher than for large ones. (2) For small distances air is a better insulator than liquid. (3) The potential at which the bend in the potential-distance curve occurs is the same for air and liquids. P. E. S.

99. *Kathode Volatilisation of Metals in Rarefied Gases.* **V. Kohlschütter.** (Zeitschr. Elektrochem. 12. pp. 869–878, Nov. 30, 1906.)—The author had come to the conclusion [see Abstract No. 1278 (1906)] that the kathode disintegration is due to the formation of endothermic chemical compounds between the metal and the gas, and that these compounds are decomposed on the cold glass walls of the vessels under the deposition of metallic mirrors. The energy required to form the compounds is the kinetic energy, with which the carriers—of atomic dimensions—of the glow discharge strike the kathode. According to this view, canal rays should produce analogous effects, though weaker than kathode rays. This is confirmed qualitatively; quantitative experiments could not be made. Underneath the hook-shaped anode of the tube is placed the kathode of brass-wire gauze, and further underneath the latter a little table whose T stem can be raised and lowered with the aid of a mercury seal without affecting the vacuum. The respective metal-foil is fitted as a cap over the table, which is surrounded by a tubular diaphragm. With the aid of a magnet and of this diaphragm, the kathode rays are kept off the metal-foil. H. B.

100. *Reflection of Electric Waves by Screens of Resonators and by Grids.* **F. C. Blake** and **C. R. Fountain.** (Phys. Rev. 23. pp. 257–278, Oct., 1906. Paper read before the Amer. Physical Soc., Oct. 28, 1905.)—An experimental study of the reflection and transmission of electric waves by grids and systems of resonators forming a screen. The chief conclusions arrived at may be summarised as follows: (1) That for a system of linear resonators, the length for maximum resonance is, within fairly wide limits, independent of the distance apart of resonators in the direction parallel to the electric force, but varies in an inverse manner with the distance between resonators in a direction perpendicular to the electric force. (2) That the mutual influence between resonators at side-on distances greater than a wave-length of the incident radiation ceases to affect appreciably the length for max. resonance. (3) That the resonator length for max. resonance depends upon the dielectric properties of the plate to which the resonators are attached. (4) That secondary resonance maxima occur only at odd multiples of the fundamental resonating length. (5) That neither the Hertz-Poincaré nor the MacDonald ratio for the quotient of wave-length by resonator length holds for a uniform linear resonator. (6) That certain systems made up of resonators of lengths differing with the distribution over the surface of a glass plate, transmit more energy than the same glass plate when bare, and that a simple general explanation of this result is afforded by the theory of optical dispersion. (7) That it is possible to increase the reflection from a grid of very long strips, any distance apart, by cutting them into lengths equal to the resonance length for that distance. (8) That the distance apart of fine wires in a grid to be perfectly opaque to electric waves of length λ when the wires are parallel to the electric force, should be of the order λ/40; when at a distance 4λ/5 apart the same wires transmit practically all the incident radiation. [See also Abstracts Nos. 1139 (1904) and 570 (1906).] E. H. B.

101. *Discharge in Solenoids with Iron Core.* **A. Battelli and L. Magri.** (Accad. Lincei, Atti, 15. pp. 397–410, Oct. 7, 1906.)—The periodic time of oscillation of the current in a circuit consisting of a condenser, the solenoid under consideration, and a spark-gap, is obtained by photographing the spark by means of the image produced by a rotating mirror. When there is no metallic core to the solenoid, the periodic time is 0·0000474 sec., and with a massive copper core it is 0·0000411. With a massive steel core the period is 0·0000449 for the first half-period, and increases to 0·0000585 for the fourth. The current is therefore not harmonic, which may be attributed to the change in permeability as the magnetising field changes. With a bundle of fine iron wires as core, the periodic time changes from 0·0000507 in the first half-period to 0·0000800 in the eleventh. Other series of experiments confirmed these results. In a further experiment it is found that with a solenoid and condenser, which gave a periodic time of 0·00000652 sec. without core, the time became 0·00000641 with an iron core, and 0·00000741 with a core of magnetite. At this high periodicity the effect of the eddy currents in the case of the iron core is sufficient to diminish the effective inductance, but in the case of the magnetite, the electrical resistivity is so high that the magnetic effect is the greater and the effective inductance is increased. These experiments prove the statements of the authors in an earlier paper [see Abstract No. 1762 (1906)]. S. G. S

102. *Normal and Abnormal Dispersion in the Region of Electric Waves.* **C. Schaefer.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 42. pp. 769–772, 1906.)—It is well known that Maxwell's theory alone in the case of non-conductors furnishes neither absorption nor dispersion. This is because all dielectrics on this theory are considered as of nature similar to the ether, and are supposed to differ from it only as regards the values of their dielectric constants. In the region of electric waves this result of theory is in good accord with observations; practically all dielectrics are transparent to Hertzian waves, and possess a refractive index independent of the wave-length, as Maxwell's theory indicates. All these simple relations become complicated in the region of light and heat rays. The simple assumptions of Maxwell's theory no longer apply to the relations between ponderable matter and waves of such very short periods. In order, therefore, to imitate in the case of electric waves the effect of molecules in the case of light-waves, resonator systems have been used by Garbasso and by Aschkinass and Schaefer. These workers obtained selective reflection, and even dispersion was obtained by Garbasso and Aschkinass with a prism built of resonating grids. But none of the experiments referred to included examples of abnormal dispersion which it is the object of the present paper to describe. The prism method was first tried, but abandoned in favour of the so-called Drude's method with its trombone-slide exciter and Lecher wire system. By this means the wave-length is determined in air, and again, when the wires are immersed in the resonator-dielectric, the ratio of the two wave-lengths being the index of refraction sought. Measurements were carried out with three resonator systems, having lengths of 41 cm., 44 cm., and 50 cm. respectively, whose

natural vibrations corresponded to waves of about double those lengths. The waves incident upon these systems had lengths varying from 72 to 98 cm. The third set of resonators showed an index of refraction falling from 1·032 to 1·010 as the incident waves increased in length, no anomaly being exhibited. But both the first and the second systems showed anomalous dispersion, the refractive index falling to a minimum and again rising as the wave-length of the incident radiation was continuously increased. These results are tabulated below, in which I., II., and III. refer to the resonator systems, λ_0 to the wave-lengths in air, and *n* to the refractive index.

Incident Radiation. $\frac{1}{2}\lambda_0$.	I. Length 41 cm. *n*.	II. Length 44 cm. *n*.	III. Length 50 cm. *n*.
cm.			
38·5	1·041	1·055	1·032
39·5	1·030	1·040	1·020
41·0	1·040	1·025	?
42·0	1·050	1·024	1·017
46·0	1·072	1·050	1·010

E. H. B.

103. *The Vibration Galvanometer.* **R. T. Wells.** (Phys. Rev. 23. pp. 504–506, Dec., 1906.)—The author investigates the possible accuracy of tuning and the way in which the magnitude of the reading of a vibration galvanometer of the type described by M. Wien [Abstract No. 1324 (1901)] varies with the amplitude of the applied e.m.f. An electrically driven tuning-fork was arranged to open and close a circuit consisting of a battery and a coil of wire, giving an intermittent unidirectional current in the coil. An alternating e.m.f. was thus induced in a second coil across the terminals of which a German-silver wire was stretched on a scale. In this wire, therefore, flows a current of fixed frequency, but the current wave is not sine-shaped. The galvanometer terminals were connected with fixed points on this wire, and the free length of the suspending wire was varied by small increments, the corresponding amplitude of vibration being noted. When the free length of the wire was 11·94 cm. resonance ensued and the amplitude of the vibration was 137·5. When, however, the free lengths were 11·9 and 12·19 the amplitudes were only 8·25 and 13·75 respectively. From the amplitudes with free lengths of 11·90 and 11·94 cm. it is seen that a reduction of the free length of 0·34 per cent., and hence a reduction of 0·17 per cent. in the free period of the needle, reduces the amplitude of the variation by 90 per cent. This shows that an instrument of this type must be accurately tuned and supplied with an e.m.f. almost perfectly constant when great precision is desired. The instrument was now tuned to the tuning-fork and its terminals connected to points on the German-silver wire at distances apart increasing by regular increments. The results show that the amplitude of the vibration is almost in exact proportion to the amplitude of the impressed p.d. A. R.

104. *Interference Experiments with Hertzian Waves.* **F. Kiebitz.** (Deutsch. Phys. Gesell., Verh. 8. 22. pp. 576–580, Nov. 30, 1906.)—The author describes some preliminary experiments in which he has attempted, in the laboratory, to obtain a greater intensity of radiation in one definite direction. The method adopted is the previously proposed one, of two similar and equal antennæ spaced a distance $\frac{1}{2}\lambda$ apart. Using antennæ 100 cm. in length, spaced 5 cm. apart ($\lambda = 10$ cm.), a helium tube glowed at 170 cm. distance in the plane including both antennæ, and only at 20 cm. distance when centrally placed at right angles to this plane. Further results are to be communicated. L. H. W.

105. *Method of producing Continuous Electrical Oscillations.* **S. G. Brown.** (Electrician, 58. pp. 201–202, Nov. 23, 1906. Écl. Électr. 49. pp. 501–502, Dec. 29, 1906.)—From experiments made with a Wehnelt electrolytic interrupter working off a direct-current circuit the author found that by placing a capacity in shunt to the poles of the interrupter, the small exposed surface being made the *kathode* and the electrolyte being alkaline (caustic potash), rapid oscillations were started in the shunt circuit, a resistance being included in the direct-current circuit. The efficiency is increased by bringing the kathode very close to the anode on the surface of the liquid, the oscillations increasing to many thousand per sec. Further experiments led to the evolution of a method in which the liquid is dispensed with. In this a disc of aluminium [apparently of size sufficient to ensure the necessary cooling] is kept slowly rotating and forms the positive electrode; the negative is a copper block resting against the edge of the disc. When 200-volt direct current is supplied to this device oscillations of the order millions per sec. are said to be produced in a Duddell shunt circuit. A glow-lamp could be lit up, being also lit up through a 9-in. brick wall employing only the inductive connection between two single-turn loops (area about 8 sq. ft.) of wire. By counterpoising the weight of the copper block the pressure on the disc can be given any definite value, and the apparatus is then self-regulating and will work all day without attention. The method is to be applied to wireless telegraphy. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

106. *Electro-capillarity.* **A. W. Vining.** (Annal. Chim. Phys. 9. pp. 272–288, Oct., 1906.)—The author has made an experimental study of the question as to whether the laws enunciated by Lippmann in 1874–5, are applicable when the mercury is replaced by another metal. In the experiments a pure metal, tin, and also an alloy (melting-point 58°) containing 9 parts of Darcet alloy to 1 part of mercury, were used. The apparatus did not differ in principle from that used by Lippmann. The following two laws were confirmed by the experiments, viz.: (1) The capillary constant at the surface of separation between a fused alloy and an electrolyte is a function of the electrical difference at the surface; (2) when a liquid surface is deformed by mechanical means the electrical difference at this surface varies in the sense that the superficial tension developed in accordance with the first law is opposed to a continuation of the movement. The author has also investigated the action of heat on the electro-capillary phenomena at the surface between mercury and acidulated water. It is found that the superficial tension maxima diminish with rising temperature; this result was obtained by constructing (for different temperatures of the small surface of a modified Lippmann electrometer) the electro-capillary curve which represents the superficial tension as a function of the p.d. D. H. J.

107. *Inertia of Selenium.* **A. Korn.** (Comptes Rendus, 143. pp. 892–895, Dec. 3, 1906. Écl. Électr. 49. pp. 476–478, Dec. 22, 1906. Phys. Zeitschr. 8. pp. 19–20, Jan. 1, 1907. Electrician, 58. p. 577, Jan. 25, 1907.)—This paper gives a description of an apparatus which is designed to compensate the inertia of selenium. Two batteries, E_1 and E_2, are put in series with two selenium cells, S_1 and S_2. In the bridge thus formed a galvanometer is introduced, its terminals being connected to points between the two cells and between the two batteries respectively. The galvanometer is arranged in a similar manner to that employed in tele-photography, so that the cell S_2 is illuminated according to the deflection of the galvanometer [see Abstract No. 125B (1906)]. If w_1 and w_2 are the resistances of the cells, all other resistances in the circuit being small in comparison, then a (the galvanometer deflection) equals $ce\,(1/w_1 - 1/w_2)$, where c is a constant for the galvanometer and e the e.m.f. of the batteries. If the resistances of the cells are the same in the dark, as may be secured by means of an added resistance, then $a = 0$ so long as the cell S_1 remains in darkness; and the galvanometer is arranged so that the cell S_2 only receives light by a deflection of the galvanometer. If now S_1 is illuminated, a current passes in the bridge, so that the galvanometer is deflected and the cell S_2 illuminated. The author then shows that, to a first approximation, the constants of the apparatus may be chosen so that the deflection a is proportional to the intensity I of the light falling on S_1.

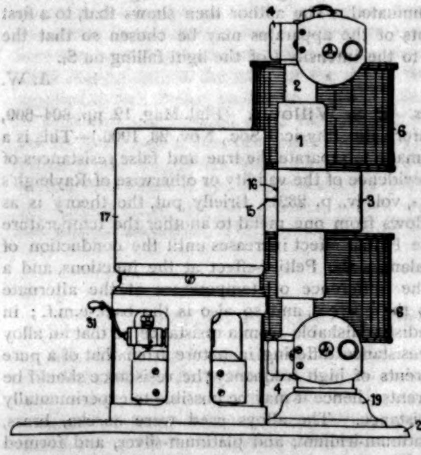
A. W.

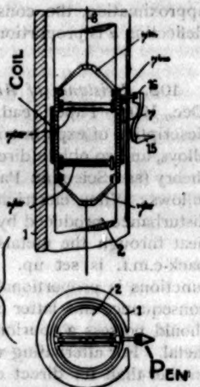
108. *Resistance of Alloys.* **R. S. Willows.** (Phil. Mag. 12. pp. 604–609, Dec., 1906. Paper read before the Physical Soc., Nov. 23, 1906.)—This is a description of experiments made to separate the true and false resistances of alloys, and so obtain direct evidence of the validity or otherwise of Rayleigh's theory (see Scientific Papers, vol. iv., p. 232). Briefly put, the theory is as follows: When electricity flows from one metal to another the temperature disturbance produced by the Peltier-effect increases until the conduction of heat through the metals balances the Peltier-effect at the junctions, and a back-e.m.f. is set up. The difference of temperature at the alternate junctions is proportional to the current, and so also is the back-e.m.f.; in consequence this latter is indistinguishable from a resistance, so that an alloy should possess a spurious resistance differing in nature from that of a pure metal. For alternating currents of high frequency the resistance should be smaller than for direct currents; hence it may be possible to experimentally determine the spurious resistance. The alloys used were eureka, brass, platinoid, German-silver, platinum-iridium, and platinum-silver, and formed in turn one of the arms of a Wheatstone's bridge, of which the adjacent arm was a simple metal. No certain differences could be detected between the resistance of an alloy to direct and to alternating currents, the temperature of the observations approximating to 20° C., 100° C., and that of solid CO_2. The author hopes to carry out further experiments to determine whether these negative results are due to the frequency (varied from 10 to 980 per sec.) being too small. F. E. S.

109. *Measurement of very large Currents.* **C. Limb.** (Rev. Électrique, 6. pp. 84–92, Aug., 15, 1906. From La Houille Blanche.)—The measurement of very large currents presents great difficulty in practice. The

author gives the theory of an absolute wattmeter which can be used to measure the power, and hence, when the voltage is known, the current in a circuit. It can be designed to measure currents up to 100 kilo-amps. The form of the wattmeter is similar to that of a simple tangent galvanometer, but instead of a magnetised needle a little coil is suspended, which is connected as a shunt across the main circuit. The main coil is practically a solid of revolution formed by the revolution of a rectangle about a line parallel to a side and exterior to the rectangle. The necessary formulæ and corrections are then studied in detail, the author only assuming Laplace's law, giving the force produced by an element of current. The mathematical reasoning has been considerably simplified and can be readily followed. In conclusion, the corrections to be applied to the apparatus when used to measure power in alternating-current circuits are given. A. R.

110. *Recording Galvanometer of Blondel and Ragonot.* **Boutin.** (Soc. Int. Élect., Bull. 6. pp. 419–437, Nov., 1906.)—This is a modified form of moving-coil galvanometer, in which a horizontal circular coil moves vertically along its axis in the annular space between two concentric cylindrical poles. The coil carries a pen which projects through a vertical slot in the outer pole, and records the movement of the coil on a drum, the axis of which is parallel to that of the coil. The general arrangement of the instrument is shown in the Figs. The suspensions of the coil, which convey the current, pass along the axis of the poles and over two aluminium pulleys, one at each end, which keep the suspension taut by means of spira springs. The field between the two poles is very uniform, and the deflections of the coil are proportional to the currents producing them. The forces on the needle are comparatively large, and render the effects of pen-friction unimportant. The damping is magnetic, being produced by a cylindrical aluminium tube on which the coil is mounted. The instrument may be conveniently applied to the strobographic recording of periodic electric currents. J. D. C.





111. *New Static Machine after Töpler.* (Archives d. Él. Médicale, 14. pp. 630–639, Aug. 25, 1906.)—The constructional details are described. An 8-disc machine gives 1 milliamp. with a Chabaud tube, and when short-circuited through a milliammeter of negligible resistance gives 1·1 milliamps., under which circumstances a Wimshurst machine would give practically no output. A very soft tube can thus be employed and yet good efficiency be obtained. L. H. W.

112. *High-frequency Generator.* (D. R.-P. 169,628. Elektrochem. Zeitschr. 13. p. 206, Dec., 1906. Abstract.)—A generator for high-frequency currents is proposed by E. Ruhmer and A. Pieper, in which a disc is rotated in proximity to an alternating-current field; by this means poles of alternating polarity are created on the periphery of the disc, and such poles are caused to induce currents in other windings spaced round the periphery of the disc. L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

113. *Induced Magnetism in Cylinders and Ellipsoids.* **T. Yosida** and **H. Kadooka.** (Physico-Mathematical Soc., Tokyo, Proc. 3. 8. pp. 150–158, Oct., 1906.)—A description of experimental determinations of the density of magnetism and its distribution on cylinders and ellipsoids. The method of investigation adopted was the usual ballistic method of observing the induction current when a small coil is slid off the magnet, the only difference being in the construction of the coil, which was a differential one, consisting of a rigidly connected pair of coils of the same number of turns wound in opposite directions, so that the ballistic effect on the galvanometer is due to the leakage of the lines of force between the two coils. The results are tabulated and curves plotted. [See also Abstract No. 201 (1900).] A. W.

114. *Wiedemann-effect at High Temperatures.* **S. Shimizu** and **T. Tanakadate.** (Physico-Mathematical Soc., Tokyo, Proc. 3. 8. pp. 142–149, Oct., 1906.)—Experiments were made on various specimens of nickel, nickel steel, tungsten steel, and Swedish iron, and the results show that the Wiedemann-effect for the above ferromagnetic substances almost vanishes near the critical temperatures of the metals. When, however, the magnetic fields are high, a small amount of twist exists for a certain interval above the critical temperature. Some remarkable results were obtained on annealing the specimens, for details of which the original paper should be consulted. The relation between the twist and temperature under both constant longitudinal and constant circular magnetic field is nearly analogous to that of length-change by magnetisation and temperature. A. W.

115. *Transversal Magnetisation and the Conductivity of Metals.* **L. Grunmach.** [Experimental work by **F. Weidert.**] (Phys. Zeitschr. 7. pp. 729–740; Discussion, p. 740, Nov. 1, 1906. Paper read before the 78 Naturforscherversamml., Stuttgart, Sept. 16–22, 1906. Amplified in Ann. d. Physik, 22. 1. pp. 141–179, Dec. 28, 1906. Abstracts in Electrician, 58. pp. 256–257, Nov. 30, 1906. Écl. Électr. 49. pp. 381–388, Dec. 8, 1906.)—Various metals were taken in the form of thin wires, and exposed, when twisted into a spiral, to magnetic fields of various intensities, the axis of the wires being at right angles to the lines of force of the field. The change in resistance of the metals was observed by means of a differential galvanometer, suitable precautions being taken to obtain accurate indications on the scale of the mirror galvanometer. The results are given in a set of tables, and also expressed in curves in which the quantity $\Delta W/W_t$ (or the change of resistance ΔW as a fraction of the total resistance W_t at the temperature t) is taken as ordinate and the intensity of field as abscissa. From these results there is made manifest a marked difference between the ferromagnetic metals and the para- and diamagnetic. The latter show throughout an increase of resistance in the magnetic field, while a decrease occurs only in the case of the ferromagnetic metals, Fe, Ni, Co. With the exception of tantalum (in the case of which the magnitudes measured were too small to admit of certainty), all the paramagnetic and diamagnetic metals examined showed an increase of resistance, which became more rapid as the intensity of field was increased. The paramagnetic and diamagnetic metals tested, arranged in order of the magnitude of their change of resistance in strong fields, are as follows: (Bi) Cd, Zn, Ag, Au, Cu, Sn, Pd, Pb, Pt, Ta. The three ferromagnetic metals exhibited a quite different behaviour. In strong fields all three show a decrease of resistance. In the case of Co the resistance decreases at first slowly, and then more rapidly as the field strength rises; from 2,000 to 9,000 gauss the decrease is nearly proportional to the increase in intensity, finally, in stronger fields, the decrease is slow. With three specimens of iron the behaviour was peculiar. First the resistance increased as the intensity of the magnetic field was raised, and attained a maximum for intensity of field about 4,000 gauss. At about 8,000 gauss the resistance of the iron had decreased to its original value, and beyond this field intensity a decrease of resistance appeared as the strength of the field increased. This behaviour does not appear in all cases; one specimen of iron examined exhibited a continuous decrease of resistance with increasing field intensity, this decrease becoming more rapid as the intensity of field rose to values over 10,000. A specimen of nickel wire showed first of all a slight increase of resistance in fields of low intensity, but a rapid decrease in fields above 600 gauss, which became slower in very strong fields. The behaviour of Co was similar to that of Ni, except that there was no initial increase of resistance and the falling off in resistance was not so rapid as the field was increased. Of the ferromagnetic metals in strong fields Ni shows the greatest decrease of resistance, then follows Co, and next Fe. The results may be of importance in connection with the theory of the motion of electrons in metals. J. J. S.

116. *Magnetic Hysteresis in Iron for High-frequency Oscillations.* **A. Battelli and L. Magri.** (Accad. Lincei, Atti, 15. pp. 485–492, Oct. 21, 1906.)—The Braun tube is employed to obtain the magnetisation cycle, the iron being in the form of wires well insulated from each other to avoid eddy currents as far as possible. With steel wires of 0·005 cm. diam. the cycle is of nearly the same shape at 50 alternations per sec. as at 10,000 alternations per sec.; the same holds with iron wires of 0·01 cm. diam., but the area of the hysteresis loop is slightly less at the higher frequency in both cases. With iron wire of 0·08 cm. diam. the cycle is greatly modified at the higher frequency and the area increased, and in the case of a massive steel core the curve becomes an ellipse. This modification of the curve at high frequencies when the core is large is due to eddy currents, and the first experiments show that the cycle is very little affected by the frequency when eddy currents are eliminated, and that at high frequencies a small diminution in hysteresis occurs. [See Abstract No. 1762 (1906).] S. G. S.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

117. *New Radio-chromometric Apparatus.* **J. Belot.** (Archives d'Él. Médicale, 14. pp. 851–854, Nov. 10, 1906. Paper read before the Assoc. Franç. pour l'Avancement des Sciences, at Lyons.)—The apparatus consists of a wooden box at one end of which is the radio-chrometric system, the other end having an opening for observation. The system is based on the comparison between the luminosity of the portion of the platinocyanide screen contained in the box affected by rays passing through a silver plate and the luminosity of the portion affected by rays passing through aluminium of graduated thicknesses. The aluminium scale is a sliding one and rectangular in shape. The arrangement is such that the screen is affected by rays passing through only two succeeding degrees of the scale at the same time, which enables the observer to decide quickly. The estimation can be equally well performed in daylight. H. W. P. Y.

118. *Oscillating-current Lamp.* (West. Electn. 39. p. 458, Dec. 8, 1906.)—A high-frequency lamp for producing violet rays for medical purposes, devised by J. E. Seeley, is described and illustrated from the U.S. Patent specification. The primary is a flat ribbon spiral outside the lamp case, the secondary spiral being inside the case and connected to a spark-gap having iron electrodes. The outer end of the secondary is connected to the inner end of the primary. The lamp is said to work at a comparatively low potential off a high-frequency apparatus. L. H. W.

REFERENCES.

119. *Phase-change on Reflection of Electric Waves at Gratings.* **C. Schaefer** and **M. Laugwitz.** (Ann d. Physik, 21. 3. pp. 587–594, Nov. 20, 1906. Phys. Inst. d. Univ., Breslau, Sept., 1906. Écl. Électr. 49. pp. 500–501, Dec. 29, 1906.)—Describes experiments as to the phase-change suffered by electric waves on reflection at various gratings. The authors find that the theory of J. J. Thomson gives the phase-change correctly as to sign and general qualitative behaviour, but quantitatively it differs somewhat from the results of their experiments. [See also Abstract No. 1481 (1906).] E. H. B.

120. *Unusual Action of Röntgen Rays on the Skin.* **F. Barjon** and **Nogier.** (Archives d'Él. Médicale, 14. pp. 706–712, Sept. 25, 1906. Paper read before the Assoc. Franç. pour l'Avancement des Sciences, at Lyons.)—In this paper cases are described in which unusual forms of radio-dermatitis occurred on areas of the skin other than that to which the rays have been applied. H. W. P. Y.

121. *Radiations and Emanations from Radio-active Substances.* **V. Balthazard.** (Archives d'Él. Médicale, 14. pp. 403–414, June 10, 1906. Paper read before the 15th Congrès internat. de Médecine, Lisbon, April, 1906.)—A *résumé* from the physiological and therapeutic standpoint.

122. *Pigmentation of the Hair and Beard due to Exposure to Röntgen Rays.* **A. Imbert** and **H. Marquès.** (Comptes Rendus, 143. pp. 192–193, July 16, 1906.)

123. *Magnetic Survey of the North Pacific Ocean.* **L. A. Bauer.** (Terrestrial Magnetism, 11. pp. 65–92, June, 1906. Summary of two papers read before the Philosoph. Soc., Washington, Oct. 1905, and April, 1906.)—Preliminary results.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

124. *Allotropic Forms of Silver and Gold.* **E. Cohen.** (Zeitschr. Elektrochem. 12. pp. 589–591; Discussion, pp. 591–592, Aug. 10, 1906. Paper read before the Deutsch. Bunsen-Gesell., Dresden, May 21, 1906.)—The author has shown that the existence of the three allotropes described by Thomsen is doubtful, since the p.d. between Au and Auα or between Au and Auβ is of the same order as that between various preparations of the same form. Similarly, with the various modifications of silver, of which three are described, the p.d. between the various forms was of the same order as that existing between various samples of the same modification. The author concludes that silver exists in only one form. F. J. B.

125. *Behaviour of Barium and Calcium Carbonate at High Temperatures.* **H. E. Boeke.** (Zeitschr. Anorg. Chem. 50. 3. pp. 244–248, Aug. 31, 1906. Inst. f. anorg. Chemie d. Univ., Göttingen, June, 1906.)—When barium carbonate is slowly heated a sudden rise of temperature occurs with great regularity within about 2° of 811° C. The arrest in the cooling-curve is less sharply marked, but takes place within a few degrees of the above temperature. The melting of barium carbonate in an open crucible at 900° is due to loss of CO_2. In an atmosphere of CO_2 incipient melting occurs at 1,350°, but even at 1,380° melting is not complete, and there is some loss of CO_2. When arragonite is heated to 470° it suddenly becomes opaque, and although the crystals retain their shape, there is no doubt as to their conversion into calcite; the change is, however, not reversible. When heated under 30 atmos. pressure of CO_2, calcium carbonate is partially dissociated but does not melt. T. M. L.

126. *Reduction of Chromium Oxide by Boron.* **B. du Jassonneix.** (Comptes Rendus, 143. pp. 897–899, Dec. , 1906.)—By heating in the electric furnace mixtures of chromium oxide with boron, contained in magnesia crucibles, alloys are produced containing from 5 to 17 per cent. combined boron, and having the densities 6·8 (7 per cent. B) to 6·1 (16 per cent. B). Any excess of boron beyond 17 per cent. is present in the form of boride of carbon, the compound CrB representing the limit of saturation of chromium with boron. This latter compound does not exist in these alloys in a well-defined crystalline state. W. H. Si.

127. *Possible Types o, Vapour-pressure Curves for Binary Mixtures.* **A. Marshall.** (Chem. Soc., Journ. 89. pp. 1350–1386, Sept., 1906.)—It is shown that, while there are four types of curves showing the variations of partial pressure with molecular composition, there are twelve types of total pressure curves; that instances of each of these types are known; that but one maximum or minimum can occur in the total pressure curve for substances miscible in all proportions; that for no partially miscible liquid is the total pressure equal to the vapour pressure of the more volatile component, though in a few cases there is a rough approximation to equality. Methods of determining and calculating the total and partial pressures of binary mixtures are discussed, and the results of experimental investigations of trinitroglycerol and acetone, diethylamine and acetone, ethyl alcohol and methyl ethyl ketone, water and methyl ethyl ketone, water and methyl acetate, water and ether, water and amyl alcohol, are given. R. E. B.

128. *Antimony-Thallium Alloys.* **R. S. Williams.** (Zeitschr. Anorg. Chem. 50. 2. pp. 127–132, July 30, 1906. Metallog. Communication from the Inst. f. anorg. Chemie d. Univ., Göttingen.)—Gives the complete thermal analysis of these alloys and the resulting equilibrium curves. The freezing-point curve consists of two branches, one corresponding to the crystallisation of pure Sb, the other to that of pure Th, a eutectic being formed having a freezing-point at 195° C. The cooling curves of alloys from which Th separates as primary crystals show the allotropic change of thallium at 225°, and as the temperature of this change is unaffected by the composition of the alloy, the author concludes that no Sb is dissolved in the Th. At a temperature slightly below that of the formation of the eutectic (187°) the alloys undergo a chemical change, the compound $SbTl_3$ being formed; but this reaction is never complete, so that alloys consisting of $SbTl_3$ only have not been obtained. W. Ros.

129. *Gold-Bismuth and Gold-Antimony Alloys.* **R. Vogel.** (Zeitschr. Anorg. Chem. 50. 2. pp. 145–157, July 30, 1906. Metallog. Communication from the Inst. f. anorg. Chemie d. Univ., Göttingen.)—The equilibrium diagram of the Au-Bi alloys as given by the author is of the simplest type, the freezing-point curve consisting of two straight branches, starting from the freezing-points of Au and Bi respectively, and meeting at the eutectic point near 240° C. corresponding to a eutectic containing about 8 per cent. Bi. The absence of compounds and the existence of a single eutectic only is confirmed by the microscopic examination of the alloys, whose structure is illustrated in the paper. The equilibrium diagram of the AuSb series is more complicated, the existence of a compound $AuSb_2$ being indicated by a hidden maximum on the freezing-point curve, this evidence being confirmed by considerations of the duration of the eutectic arrests. Only one eutectic is indicated on the diagram, having a freezing-point near 360° C. and containing 28 per cent. Sb; another horizontal line, at 460° C., represents the crystallisation of $AuSb_2$ from the fusion; the microstructure confirms these conclusions. The author notes the contrasting behaviour of the two elements, Sb and Bi, which are chemically similar, in their behaviour towards Au. W. Ros.

130. *Alloys of Silver with Thallium, Bismuth, and Antimony.* **G. I. Petrenko.** (Zeitschr. Anorg. Chem. 50. 2. pp. 133–144, July 30, 1906. Metallog. Communication from the Inst. f. anorg. Chemie d. Univ., Göttingen.)—Describes the complete thermal and microscopic examination of these alloys. Silver-thallium alloys containing up to 10 per cent. Tl form homogeneous mixed crystals if cooled sufficiently slowly, but alloys richer in Tl contain these crystals in a matrix of eutectic whose freezing-point lies at 287° C. The eutectic point lies near 97 per cent. Tl, and beyond this point primary crystals of Tl are found in the alloys. The freezing-point curve of the Ag-Bi series consists of two branches; along the first of these Ag containing up to 5 per cent. Bi in solid solution separates, the eutectic solidifying at 261° and corresponding to a content of 2·5 per cent. Ag. The form of one of the freezing-point curves is peculiar, being partly concave upwards, but no compound is indicated. The equilibrium diagram of the Ag-Sb series is more complicated, the existence of the compound Ag_3Sb being indicated by a hidden maximum in the freezing-point curve, and by considerations of the duration of eutectic arrests; it is further found that at 560° a reversible reaction takes place resulting in the formation of the compound Ag_3Sb from a saturated solid solution of Sb and Ag on cooling, the action being reversed on heating. The authors compare their results with those of Heycock and Neville, and find good agreement. W. Ros.

131. *Practical Applications of Microscopic Metallography.* **H. le Chatelier.** (Soc. d'Encouragement. Rev. de Métallurgie, Mém. 3. pp. 859–888, Oct. 1, 1906. Paper read at Brussels before the Internat. Assoc. for Testing Materials, Sept. 6, 1906.)—Describes, chiefly by means of numerous examples, how microscopic examination of metals may be of direct service in works practice; the uses described come under the heads of chemical analysis, determination of the proximate chemical constitution and physical structure as throwing light on the past history of the metal as to casting temperature, heat and mechanical treatment, &c. Examples are taken from all branches of industry dealing with metals, including brass, bronze, and other alloys, and the whole field of the steel industry, as well as constructional engineering works. The author dwells on the simplicity and cheapness of the outfit required for metallography, as compared with chemical analysis or mechanical testing, and indicates his opinion that the costly microscopic outfits installed in some works, although essential to scientific research, are superfluous for works purposes. W. Ros.

132. *Deformation and Fracture of Iron and Mild Steel.* **W. Rosenhain.** (Iron and Steel Inst., Journ. 70. pp. 189–228, 1906. Carnegie Scholar's Report.)—The author gives further proof of the absence of deformation except by slip-bands and twinning, by showing the absence of distortion of a minute surface pattern formed between two adjacent slip-bands. By means of the method of examining slip-bands in section [see Abstract No. 1809 (1905)], the original view of the nature of double boundaries is confirmed. Microscopic evidence is given in support of the view that the temporary plasticity of metals immediately after overstrain is due to the formation of a mobile layer upon surfaces of slip [see also Abstract No. 2506B (1904)]; this can be seen in section upon polishing and etching immediately, but not after recovery. It is observed that [static ?] tensile fractures run almost indifferently through ferrite and pearlite, probably because the previous extension of the metal has weakened, and even in part ruptured, the pearlite. [Static ?] bending fractures are found to be intermediate in character between these and impact fractures [see Abstract No. 266B (1905)]. F. R.

133. *Quaternary Steels.* **L. Guillet.** (Iron and Steel Inst., Journ. 70. pp. 1–141, 1906. Carnegie Scholar's Report. Metallurgie, 3. pp. 581–586, Sept. 8, and pp. 622–627, Sept. 22, 1906. Abstract. Mech. Eng. 18. pp. 68–70, July 14, and pp. 93–95, July 21, 1906. Electrochem. Ind., N.Y. 4. pp. 311–314, Aug., 1906.)—This report deals with ten series of quaternary steels; of these the following have been already dealt with: V-Ni [see Abstracts Nos. 609 and 611 (1906)]; Cr-Ni [see Abstract No. 152B (1906)]; and Ni-Mn [see Abstract No. 404 (1906)]. The addition of W to Ni steel causes an increase of hardness, but these steels, even after quenching, retain a distinctly high elongation. The effect of Mo in Ni steels is very similar to, but more intense than that of W. In the case of Ni-V steels it is important to keep the Ni content high, but between 2 and 7 per cent., and carbon low—0·1 to 0·8 per cent.—to obtain the most useful products; 0·8 to 0·1 or even 0·05 per cent. V is suitable. Si in Ni steels causes an increase of brittleness, particularly across the direction of rolling, but permits of greater hardness being obtained by quenching. The addition of Al to Ni steels causes increase of strength with diminished elongation, and the formation of martensite is hindered. The properties of Mn-Cr steels are absolutely analogous to those of Ni-Cr steels. Si increases the strength of Mn steel, especially in the quenched condition. High Mn steels should not contain over 1 per cent. Si, nor high Si steels over 1 per cent. Mn. Cr-W steels are chiefly interesting as high-speed tool steels. They are best treated so as to be sorbitic (or troostitic), or to contain the triple carbide completely dissolved after annealing; the rate of cooling and the composition appear to influence them but slightly; the duration and temperature of annealing are of greatest importance. The general correlation of the microstructure of quaternary steels with their mechanical properties is very similar to the case of ternary steels [see Abstract No. 1670 (1905)]. Mn, Cr, W, and Mo add their influence to that of Ni in pearlitic Ni steels near the martensitic boundary [see Abstract No. 1787B (1904)]; V, Si, and Al have the opposite effect. With the exception of those steels whose field of application is very specially limited, the only interesting series, commercially, are the Ni-V, Ni-W, and Cr-V steels. [See also Abstract No. 687 (1906).] F. R.

134. *Influence of Carbon Condition, and Heat Treatment, on Strength of Cast Iron.* **W. H. Hatfield.** (Iron and Steel Inst., Journ. 70. pp. 157–188, 1906. Carnegie Scholar's Report. Metallurgie, 8. pp. 671–672, Oct. 8, 1906. Abstract.) —The author is led to believe that at least a small percentage of the free carbon, if any, in a cast iron, is annealing carbon. He finds that Ledebur's distinction between graphite and temper-carbon—viz., that the former will not combine with solid iron, but the latter will—does not hold good. In a series of irons with varying Si contents, but uniformly low in other elements, the white irons low in Si gave high results, *e.g.*, 22·8 tons per sq. in.; these results are explainable by the microscopic data of the carbon condition. The effect of pouring temperature was moderate, and did not persist after annealing [see also Abstract No. 2220B (1904)]. Annealing white irons gave good results, with Si from 0·45 to 1·9 per cent; in these the presence of pearlite is accompanied by high strength, *e.g.*, in one case 32·6 tons per sq. in. F. R.

135. *Influence of Vanadium on Iron and Steel.* **P. Pütz.** (Metallurgie, 8. pp. 635–638, Sept. 22; 649–656, Oct. 8; 677–686, Oct. 22, and pp. 714–721, Nov. 8, 1906. Communication from the Aachener eisenhüttenmänn. Inst.)—Gives results of experiments on the critical points, mechanical properties, heat treatment, and microstructure of fifty vanadium steels, containing from 0·05 to 2 per cent. carbon, and from 0 to 1·5 per cent. vanadium. The paper does not admit of brief abstraction. The portions of the work which cover the same field as Guillet's [see Abstract No. 92B (1905)] confirm his results. F. R.

136. *Brittleness and Blisters in Thin Steel Sheets.* **E. F. Law.** (Iron and Steel Inst., Journ. 69. pp. 134–144; Discussion and Correspondence, pp. 145–

160, 1906. Mech. Eng. 17. pp. 755–758, June 2, 1906. Abstracts in Metallurgie, 3. pp. 350–356, May 22, 1906. Iron and Steel Mag. 11. pp. 498–503, June, 1906.) —The author's investigations lead to the following conclusions: (1) Oxidised steel will give rise to blistered sheets, and this defect is more liable to occur with Bessemer than with open-hearth steel. (2) Steel high in sulphur and phosphorus will cause brittleness in sheets, especially if these latter are rolled from large and slowly-cooled ingots, in which the maximum of segregation has taken place. L. H. W.

137. *Nickel-Chromium Steels.* **L. Guillet.** (Soc. d'Encouragement. Rev. de Métallurgie, Mém. 3. pp. 332–354, Oct. 1, 1906.)—The microstructure of these steels is roughly represented graphically by combining the diagram of Cr steels with that of Ni steels, but not so closely as in the case of Ni-Mn steels [see Abstract No. 404 (1906)], as the demarcation between carbide steels and steels not showing the special carbide is incomplete. The percentages of carbon of the series were about 0·2 and 0·8; of Cr, 3, 10, and 20; of Ni, 5, 12, and 30. The mechanical properties of the steels in the normal, quenched, annealed, or liquid-air cooled states, are, similarly to microstructure, generally a combination of those of Ni steels and Cr steels. The hardness of quenched pearlitic Ni-Cr steels is greater than that of either Ni or Cr steels. The pearlitic Ni-Cr steels also take a harder exterior when case-hardened than do either Ni or Cr steels. A study of the cementation of the steels supports the author's views as to their microstructure. F. R.

138. *Theory of Cementation.* **Partiot.** (Soc. d'Encouragement. Rev. de Métallurgie, Mém. 3. pp. 401–406, Oct. 1, 1906.)—Discusses the subject from several points of view, and points out that the lack of agreement between the results obtained by Ledebur and by Guillet is due to the differences in conditions of treatment, notably heating, and in the dimensions of specimens. There is room for progress in regard to anti-cements, and it is possible that some cementing materials will be found to act without bringing about so much brittleness as others. Another important problem is to find the conditions necessary to produce least deformation of the piece in case-hardening. F. R.

139. *Hardening of Steel.* **P. Lejeune.** (Soc. d'Encouragement. Rev. de Métallurgie, Mém. 3. pp. 394–400, Oct. 1, 1906.)—Describes experiments made with a view to studying the propagation of cooling in large pieces of steel; the author uses two thermo-couples, electrically insulated from but otherwise in close contact with the specimen, one of the couples being inserted into the centre of the specimen, while the other was placed half-way between the centre and the periphery of the specimen, the latter being a steel cylinder 5 cm. in height and diameter; one of the couples gives the absolute temperature of the specimen, while the difference between the two couples is indicated by Saladin's double galvanometer, the indications of both being recorded photographically. A number of curves are given in the paper, but this is done tentatively, and the whole is only intended to describe a promising experimental method of studying the mode of action of different quenching-baths. W. Ros.

140. *Rate of Etching by Metallographic Reagents.* **P. Lejeune.** (Soc. d'Encouragement. Rev. de Métallurgie, Mém. 3. pp. 312–318, Oct. 1, 1906.)—Studies

the question from the point of view of the state of molecular association of the etching solution. Viscosity and the dielectric constant are the factors affecting the ionising power of the solute. The effect of viscosity is illustrated by the weakness of the etching power of a solution of picric acid in glycerine. Four per cent. solution of picric acid in the following solvents gave increasing slowness of etching in the order shown: acetonitrile, benzonitrile, propionitrile, carefully distilled methyl alcohol, ethyl alcohol. These are in the order of the conductivities of solutions of NaCl in the same solvents, but the author has not yet measured the conductivities of the etching solutions named. F. R.

141. *Separation of Graphite in Iron-Carbon Alloys.* **F. Wüst.** (Metallurgie, 8. pp. 757–760, Nov. 22, 1906. Communication from the eisenhüttenmänn. Inst. der kgl. techn. Hochschule, Aachen.)—The author gives experimental evidence to show that the separation of graphite is dependent upon the rate at which the alloy is cooled through the 1,180° C. eutectic point. Silicon, which favours the separation of graphite, does so by lengthening the pause at 1,180°; whilst manganese and probably also sulphur shorten the pause and render the separation of graphite more difficult. Photomicrographs are given. F. R.

142. *Malleable Cast Iron.* **G. A. Akerlind.** (Mech. Eng. 17. pp. 910–912, June 80, and 18. pp. 829–881, Sept. 8, 1906. Abstract of paper read at the April Meeting of the Scandinavian Technical Soc.)—Describes the process of manufacture with particular reference to moderate-sized malleable castings for freight cars. As the tensile strength is from 40,000 to 50,000 lbs. per sq. in. with 6 to 1 per cent. elongation, as compared with 20,000 to 80,000 lbs. for cast iron, it is possible to use thin castings, but the minimum is in many cases decided by the liability to cracking in cooling, which is great owing to the great shrinkage of the metal. For the class of work under consideration the author gives $\frac{1}{4}$ in. as the thickness for castings of about 10 lbs. weight, $\frac{3}{16}$ in. for 15 to 20 lbs., and $\frac{3}{8}$ to $\frac{1}{2}$ in. for 40 lbs. and over. The design of the details of the casting should be such as to interfere as little as possible with its contraction in the mould. F. R.

143. *Conductivity of Colloidal Solutions.* **G. Malfitano.** (Comptes Rendus, 148. pp. 172–174, July 16, 1906.)—The author shows that the results obtained by himself and Duclaux, working with colloidal solutions [see Abstracts Nos. 812 and 1826 (1905)], though apparently conflicting, may be readily reconciled. The difference between the conductivity of the entire colloidal liquid and that of the solution after filtration through a membrane does not represent the specific conductivity of the colloid, the variation in value of this difference indicating that the reciprocal influences of the colloid and solution affect not only their respective compositions, but also their state of ionisation and the volume of the colloid. W. H. Sı

144. *Size of the Particles in Hydrosols.* **R. Zsigmondy.** (Zeitschr. Elektrochem. 12. pp. 681–685, Aug. 17, 1906. Paper read before the 18th Hauptversamml. der Deutsch. Bunsen-Gesell., May, 22, in Dresden.)—In the case of gold-suspensions the separate particles can be seen if the diameter is 8 $\mu\mu$ or more; the ultramicroscopic particles which show up as circles of light when examined by the author's method have a diam. of 1·7 to 8 $\mu\mu$.

Particles of 1 μμ diam. are quite invisible. The colour produced at first becomes more intense as the size decreases, but remains substantially constant from 50 to 1 μμ. Recently the examination of other colloidal liquids has revealed the presence of ultramicroscopic particles, especially in glycogen, albuminous urine, and a number of dye-stuffs of high molecular weight such as indulin, violet black, aniline blue, &c. Although it cannot yet be said that all colloidal solutions contain suspended particles, it is evident that such particles occur much more frequently than has generally been supposed. T. M. L.

145. *Colloidal Alkali Metals.* **H. Siedentopf.** (Zeitschr. Elektrochem. 12. pp. 635–636; Discussion, pp. 636–637, Aug. 17, 1906. Paper read before the 18th Hauptversamml. der Deutsch. Bunsen-Gesell., May 22, in Dresden.)—Coloured aggregates of ultramicroscopic particles of sodium or potassium can be prepared in anhydrous sodium chloride crystals. The colour alters with the temperature, the maximum absorption changing gradually from blue to red as the temperature rises. Above 500° C. the preparation is colourless, but the red light emitted at 550° is stronger than in the case of colourless salt. Rock-salt, which is coloured naturally, becomes colourless at a lower temperature, about 270°. T. M. L.

146. *Solid Solutions in the Dissociation of Palladium and Copper Oxides.* **L. Wöhler** [with **A. Foss**]. (Zeitschr. Elektrochem. 12. pp. 781–786, Oct. 26, 1906. Chem. Inst. d. techn. Hochschule, Karlsruhe.)—In determining the pressure of gas produced by the dissociation at different temperatures of palladium and copper oxides, PdO and CuO, the time of heating was found to be an important factor. The presence of a large amount of metallic Pd usually caused a low pressure of oxygen, and this was explained as being due probably to the formation of a solid solution of metal and oxide, from which the gas escaped at a smaller pressure than from the pure oxide. In the case of copper oxide, which melts at 1,064°, it was found that repeated evacuation steadily reduced the apparent dissociation pressure and therefore, contrary to the conclusions of Debray and Joannis, a solid solution is probably produced, the concentration of which is an important factor in determining the dissociation pressure. T. M. L.

147 *Galvanic Cells produced by the Action of Light.* **M. Wilderman.** (Roy. Soc., Phil. Trans. 206. pp. 335–401, July 31, 1906. Proc., Ser. A. 77. pp. 274–276, March 29, 1906. Abstract. Chem. News, 93. p. 95, March 2, 1906.)—The production of an e.m.f. in a cell in which one only of two similar electrodes is exposed to the action of light has been studied by Becquerel and by Minchin. The results observed by them were irregular and were attributed to complex surface action, but are now shown to be definitely of the character of galvanic cells. The irregularities are due to the development of a true galvanic polarisation, but cells are now described which are reversible (*a*) in respect of the kathion, *e.g.*, Ag (light) | $AgNO_3$ (light) | $AgNO_3$ (dark) | Ag (dark); or (*b*) in respect of the anion, *e.g.*, Ag-BrAg (light) | NaBr (light) | NaBr (dark) | AgBr-Ag (light). These cells differ from ordinary constant reversible cells as follows: (1) The cell is a galvanic combination only so long as it is exposed to light; there is no permanent p.d. at the two electrodes as in an ordinary cell. (2) There is a period of induction before the max. e.m.f. is reached, and a similar lag or period of deduction

on removing the light. (3) The "sensitiveness" of the electrodes to light does not always remain the same. (4) The e.m.f. is a function of the intensity and composition of the light and of the light-absorption at the electrodes under the special conditions of the experiment. All lights appear to be more or less actinic in this respect and the effects produced are quite distinct from thermal effects. [See Abstract No. 1535 (1905).] T. M. L.

148. *The Oxide Theory of the Hydrogen-Oxygen Cell.* **R. Lorenz** and **H. Hauser.** (Zeitschr. Anorg. Chem. 51. 1. pp. 81–95, Oct. 18, 1906. From Dissertation, Zürich, 1906.)—In order to account for the different values of e.m.f. of the hydrogen-oxygen cell, the authors have carried out a number of experiments in acid, alkaline, and neutral electrolytes, using noble and base metals (measured against hydrogen). They find that in all cases there is a local process of autoxidation and that there is a definite oxide formed as end-product. While this is being formed it influences the e.m.f., and when formed is finally the sole factor in determining the e.m.f. This "oxide theory" is capable of explaining only the value 1·08, but not the higher values of the e.m.f. A. F.

149. *New Depolarisers.* (Centralblatt Accumulatoren, 7. pp. 285–286, Nov. 20, 1906.)—Preliminary communication. Non-conducting substances, solid or liquid, sulphur, perchlorobenzene, nitrobenzene, are mixed with carbon and pressed into rod shape, or brought into carbon vessels and combined with a kathode of aluminium or zinc. These depolarisers do not answer in acid or neutral solutions, but some effects are observed in caustic soda of 10 per cent. H. B.

150. *Potentials of Amalgams.* **A. Sucheni.** (Zeitschr Elektrochem. 12. pp. 726–732, Sept. 28, 1906. From the Chem.-techn. Inst. d. techn. Hochschule, Karlsruhe.)—Results are given of measurements of the potentials of thallium amalgams with respect to the decinormal electrode at 37°, made by the usual compensation method. For amalgams containing up to 43 atoms per cent. Tl the potential curve rises continuously, the alloys in this region being hence uni-phasic. On the assumption that $TlHg_2$ is the only definite compound formed, the alloys containing up to 33⅓ atoms per cent. of Tl consist only of mixtures of $TlHg_2$ with mercury. It follows also that these two substances are miscible in all proportions at 37°. From 33⅓ to 44 atoms per cent. Tl the alloys must consist of homogeneous liquid mixtures of Tl with $TlHg_2$. Also at 0° the potential curve is continuous, and, since the curve from 33 to 50 atoms per cent. Tl is horizontal, $TlHg_2$ and Tl solidify without forming solid solutions or mixed crystals. Further, Hg and $TlHg_2$ must be miscible in the solid state; with a content of less than 25 per cent. of Tl, these mixtures are also liquid at 0°. Similar complete miscibility is also shown by the potential curve at —80° C. [See also Abstracts Nos. 176, 846, and 1292 (1903).] T. H. P.

151. *Passivity and Catalysis.* **O. Sackur.** (Zeitschr. Elektrochem. 12. pp. 637–641, Aug. 17, 1906. Paper read before the 13th Hauptversamml. der Deutsch. Bunsen-Gesell., May 22, in Dresden.)—Passivity is regarded as a velocity phenomenon. The change taking place at the anode is essentially a combination of metal with oxygen or another anion; if this combination is slow the metal is said to be passive. It is suggested that the combination

takes place in two stages, the metal itself displacing hydrogen instantaneously from the acid solution, and the hydrogen being then oxidised slowly by the anions. According to this view it is therefore the hydrogen rather than the metal that becomes passive, and passivity depends on the lack of catalytic power in the metal to condition the oxidation of hydrogen. It is therefore noteworthy that the metals which most readily become passive are those like Fe and Cr, which have very little catalytic power to condition the union of hydrogen and oxygen, whilst Ag and Pt, which have a great catalytic power, are least liable to become passive. T. M. L.

152. *Periodic Phenomena in the Electrolysis of Nickel Salts.* **A. Thiel and A. Windelschmidt.** (Zeitschr. Elektrochem. 12. p. 737, Oct. 5, 1906. Chem. Inst. d. Univ., Münster, Aug., 1906.)—Periodic alterations of voltage, similar to those recorded by Küster in the case of the polysulphides, are shown during the electro-deposition of nickel as peroxide on the anode. The phenomena appear to depend on the alternate deposition and dissolution of the peroxide, and are considerably influenced by the composition and temperature of the electrolyte, as well as by the current-strength.

T. M. L.

153. *Corrosion of Iron by Acids.* **C. F. Burgess and S. G. Engle.** (Amer. Electrochem. Soc., Trans. 9. pp. 199–206; Discussion, pp. 206–210, 1906. Metallurgie, 3. pp. 602–604, Sept. 8, 1906.)—The authors watch the loss of weight of sample plates in acids at 22° C. The samples are plates of 5 sq. in. of electrolytic iron (from mixed sulphate and chloride solutions), the same iron heated to 1,000° and slowly cooled, soft transformer iron, temper steel for knives, cast iron. All the surfaces were ground smooth on an emery wheel. The rate of solution in normal sulphuric acid (hydrochloric acid is also tried) is not the same in successive hours. The averages per sq. in. per hour are: Electrolytic iron, 0·3728; same heated, 0·0091; cast iron, 0·0643; steel, 0·0971; transformer iron, 0·0093 gm. Chemically-pure zinc lost 0·1410, commercial zinc 0·2607 gm. Thus the chemically purest electrolytic iron dissolved far more rapidly than the impurer specimens; but the corrosion is much reduced by heating when the hydrogen in the iron is driven off; heating also changes the structure and makes the brittle iron soft and tough. When the sulphuric acid contains arsenic the iron becomes passive, owing probably to the formation of a surface film of arsenic on the iron; according to J. E. Stead arsenic retards the oxidation of iron. The following p.d.'s were observed against a calomel electrode at 24° C. in normal solutions :—

	In H_2SO_4.	In Neutral $FeSO_4$.	In H_2SO_4 with Arsenic.
Electrolytic iron	0·0476	0·1164	—0·078 volt
Same, heated	0·0270	0·1056	—0·146 „
Transformer iron	—0·0188	0·1028	—0·156 „
Cast iron	—0·045	0·0518	—0·115 „
Steel	—0·062	0·0308	—0·186 „

The percentage of purity is therefore not the controlling factor for rate of olution nor for potential. Electrolytic iron gives 16 per cent. more hydrogen than an equal weight of zinc; this might become important. In the *discussion*, **H. Rodman** pointed out that hydrogen for accumulator soldering, &c., is generated from iron turnings and purified by being passed through potassium permanganate. **Bancroft** remarked that the arsenic alloys which the authors prepared in an electric furnace, and which also turned passive in acids, would contain arsenic all through, not in the shape of a surface film. **Curry** and **S. Sadtler** also spoke on the influence of arsenic. **C. Hering**, **W. Arsem**, and **Bancroft** discussed the brittleness which might be due to the presence of hydrogen and of oxides; the authors did not investigate this point. **J. W. Richards** referred to the three states of iron, the α, β, γ states. H. B.

154. *The Electrical Discharge in Air and its Commercial Application.* **W. Cramp** and **S. Leetham.** (Electrician, 57. pp. 769–775, Aug. 31, 1906. Elect. Engin. 38. pp. 258–265; Discussion, p. 265, Aug. 24, 1906. Paper read before the Brit. Assoc. at York, Aug. 2, 1906. Electrochem. Ind., N.Y. 4. pp. 388–395, Oct., 1906. Électricien, 32. pp. 355–359, Dec. 8; 374–379, Dec. 15; and pp. 392–396, Dec. 22, 1906.)—Leetham discovered in 1903 that ozonised air became a much more powerful bleaching agent for flour after it had been exposed to spark discharges. H. E. Armstrong attributed the effect to the presence of nitrogen oxides. The apparatus of the authors is a steel box containing alternator, transformer, switch-box, ozoniser of the Andreoli type, and sparking device; a Root blower and a dust filter for the air are also required. With a feed of 100 cub. ft. of air per minute, the air issuing from a pipe, 8 ft. from the delivery flange of the iron case, contains 40,000 parts by volume of air, 3 of ozone, and 1 of nitrogen oxides, when 4 spark-gaps of $\frac{1}{16}$ in. length are used. The paper discusses the influence of the various forms of electrical discharges, of frequency, air velocity, length of spark-gap and shape of spark points, temperature, &c. To account for the phenomena the authors suggest ionisation of the air, by which they understand capability of discharging an electroscope. Both the ozone and the nitrogen oxide, probably N_2O_4, bleach flour—as much as 3 tons per hour at the above-mentioned rate—but the nitrogen oxide turns its colour to sepia if acting too long. It is noteworthy that the N_2O_4 cannot be found in the box itself, but only at the end of the discharge pipe some feet beyond the flange; if a longer pipe is used N_2O_4 is still formed, although the coexistence of the two gases, ozone and N_2O_4, had been considered impossible. H. B.

155. *Course of Polarisation during Electrolytic Processes.* **H. Danneel.** (Elektrotechn. Zeitschr. 27. pp. 1202–1204, Dec. 27, 1906.)—When copper sulphate is electrolysed with gradually increased e.m.f., the current intensity is relatively high after each step, but sinks slowly—more rapidly with stirring—owing to the depletion of the electrolyte, at the kathode, of Cu-ions. These ions are replenished by diffusion, and the laws of Faraday and of Fick (diffusion) enable us to calculate the diffusion-coefficient. The process becomes more lucid when we work with constant current intensity and determine the kathode potential against a normal electrode. In this way Sand [see Abstract No. 658 (1905)] has measured electrode potentials in stationary liquids, and determined diffusion-constants, as the author shows. When the liquid-like nitro-benzene does not take part in the current conduction, however, abnormally high potentials are observed, and the resulting diffusion-constants would be wrong. The electrodes appear to be changed in these instances, in which the first result of the electrolysis is, as a rule, a generation of gas; in the case of nitro-benzene hydrogen is generated which produces the reduction. Haber assumes that a film of gas is absorbed by the electrode. H. B.

156. *Behaviour of Aluminium Anodes.* **G. Schulze.** (Ann. d. Physik, 21. 5. pp. 929–954, Dec. 14, 1906. Communication from the Physikal.-Techn. Reichsanstalt.)—The author introduces a rod of aluminium, 0·7 cm. in diam. partly sheathed with rubber tubing, from below into his cylindrical cell with conical bottom, in which a semi-cylinder of platinum-foil surrounds the rod. The electrolyte consists of acids (sulphuric, boric, chromic, phosphoric, arsenic) and their neutral ammonium and other alkali salts, further of $(NH_4)_2CO_3$, $KMnO_4$, KH_2SbO_4, all in aqueous solutions; the cell is cooled to about 0° C. (− 2 to + 5° C.). Only continuous currents are applied so far, except for the capacity tests. The cell can be directly coupled for capacity tests after Maxwell-Thomson. When the skin of Al-compound formed on the Al is dried and the electrolyte in the cell replaced by mercury, the capacity determination gives the thickness of the skin. The thickness of this skin goes on increasing with the quantity of electricity passed, but the loss of voltage at the Al-anode is limited, and the final voltage is observed almost instantaneously or after hours and days. At higher temperatures higher current densities have to be applied, to obtain the same final loss of voltage, than at lower temperatures, but the Al-effect can be observed even at 100° C. in some electrolytes, contrary to the opinion of other investigators. The following observations demonstrate that the loss of voltage is not due to the skin of Al-compound, but to a gaseous film, the "active layer," forming at the same time; Guthe had suggested this in 1903. There are glow and spark discharges in the film. When the current is interrupted, the insoluble skin remains unchanged, but the gaseous film is reduced by diffusion; hence a lowering in the loss of voltage. The relation between thickness of the gaseous film and loss of voltage is the same for all the electrolytes examined, which otherwise differ considerably in their curves, and this applies also to solutions of those electrolytes in alcohol; experiments with other solvents are being made. The loss of voltage is approximately proportional to the thickness of the gaseous film. The gaseous anode film consists of oxygen. Why a hydrogen film on the kathode should not produce a similar voltage loss remains to be explained; the mobility of the negative, and sluggishness of the positive, electrons may cause the unipolarity. The potential gradient in the gaseous film, 55 volts for 5 $\mu\mu$, equivalent to 11,000,000 volts per cm., is extraordinarily high. H. B.

157. *Production of Ozone by Electrolysis of Alkali Fluorides.* **E. B. R. Prideaux.** (Faraday Soc., Trans. 2. pp. 34–35, Aug., 1906. Chem. News, 93. p. 47, Feb. 2, 1906.)—Electrolysis of aqueous hydrofluoric acid with a current density of 100 amps. per sq. dm. yields only 0·28 per cent. of ozone, but by electrolysing potassium fluoride at 0° C., using a copper kathode and an anode of platinum-foil, as much as 0·65 per cent. ozone is produced in 20 min. with a current density of 10 amps. per sq. dm. Variation of current density between 5 and 10 amps. makes little difference to the yield, but it is much reduced by raising the current to 120 amps. or prolonging the duration of the electrolysis. W. H. St.

158. *Electrolytic Reduction.* I. *Aromatic Aldehydes.* **H. D. Law.** (Chem. C., Journ. 89. pp. 1512–1519, Oct., 1906.)—On electrolytically reducing benz-

aldehyde in a dilute alcoholic solution of potassium hydroxide, with a current of about 1 amp., an almost quantitative yield of isohydro- and hydro-benzoin is obtained; the introduction of hydroxyl, methoxyl, or the group $<\substack{O\\O}>CH_2$ into the benzene nucleus of the benzaldehyde does not alter the main course of the electrolytic reduction; cuminaldehyde yields hydro- and isohydrocuminoin; similarly with piperonaldehyde, anisaldehyde, vanillin, salicylaldehyde. Aldehydes such as furfural and cinnamaldehyde, which contain an unsaturated carbon atom, yield nothing but a resinous product, and thus confirm the statement already made by the author, that unsaturated aldehydes polymerise under the influence of an electric strain. Benzoin yields tetraphenylerythritol; and piperonyloin, anisoin, and cuminoin give analogous products when electrolytically reduced. D. H. J.

159. *Electrolytic Reduction.* II. *Use of Electrodes.* **H. D. Law.** (Chem. Soc., Journ. 89. pp. 1520–1527, Oct., 1906.)—The author shows that when benzaldehyde (or other similar aldehyde) is reduced electrolytically, the velocity of the reaction is chiefly dependent on the rate of diffusion of the benzaldehyde in the kathodic region, and is independent of the potential of the kathode; the actual reduction takes a relatively short time. This result holds strictly when the kathodic concentration is small, and is modified somewhat when this condition is not fulfilled. D. H. J.

160. *Electrolytic Oxidation.* **H. D. Law.** (Chem. Soc., Journ. 89. pp. 1437–1453, Sept., 1906.)—The electrolytic oxidation of dissolved benzoin and of other similar compounds was studied by the author. Benzoin gives, in addition to tarry matter, benzil, benzaldehyde, and benzoic acid:—

$$C_6H_5 . CH(OH) . COC_6H_5 + O = C_6H_5 . CO . COC_6H_5 + H_2O$$
$$C_6H_5 . CH(OH) . COC_6H_5 + O = C_6H_5 . CHO + C_6H_5 . CO_2H.$$

The yields vary greatly with the conditions; thus strongly acid solutions promote the formation of tar, but none is observed with a low anodic discharge. Experiments with bodies resembling benzoin gave similar results to the above. Thus cuminoin, on being oxidised electrolytically, yields cumic acid, cuminol, and tar; furoin gives furil and tar, benzofurin gives benzoic acid and tar. D. H. J.

REFERENCES.

161. *Catalysis in Heterogeneous Systems, and a New Oxide of Mercury.* **G. Bredig.** (Zeitschr. Elektrochem. 12. pp. 581–587; Discussion, pp. 587–589, Aug. 10, 1906. Paper read before the Deutsch. Bunsen-Gesell., Dresden, May 21, 1906.)—The catalytic decomposition of hydrogen peroxide by platinised platinum plates is studied. F. J. B.

162. *Equilibrium in the System: Bismuth and Sulphur.* **A. H. W. Aten.** (Zeitschr. Anorg. Chem. 47. 3. pp. 386–398, Nov. 9, 1905. Chem. Lab. d. Univ., Amsterdam, Aug., 1905.)—The author criticises the conclusions drawn by Pélabon from his experimental investigation of the system: bismuth and sulphur [Abstract No. 2939 (1904)]. T. H. P.

163. *Densities of Solutions of Sodium Carbonate and Hydroxide.* **R. Wegscheider.** (Akad. Wiss. Wien, Sitz. Ber. 114. 2b. pp. 1121–1138, Oct. and Nov.,

1905. From the I. Chem. Laborat. der k.k. Univ., Wien.)—The author corrects the values of some of the constants in the expression previously given by himself and Walter [Abstract No. 413 (1906)]. T. H. P.

164. *Relations between Volume and Co-volume.* **H. Moulin.** (Soc. Franç. Phys., Bull. 2. pp. 141–145, 1906.)—The author suggests the addition of a new term, $c(1+\alpha t)/(v-b)^3$, to the right-hand side of van der Waals' equation, to express the action of the atoms on one another as distinct from the action of the whole molecules. The suggestion is supported by the results of experiments with carbon dioxide. D. H. J.

165. *Instructive Laboratory Experiment in Electro-chemistry.* **W. H. Walker.** (Amer. Electrochem. Soc., Trans. 9. pp. 23–29 ; Discussion, pp. 29–30, 1906.)—The electrolytic preparation of bleach in an Acheson graphite crucible cell without diaphragma, with a rotating ⋂-shaped kathode-holder of hard rubber to which wires are fastened, is recommended as suitable for class instruction ; the curves elucidate the most economical preparation of hypochlorite. **J. W. Richards** and **Bancroft** agreed. H. B.

166. *Development of High-speed Tool Steel in Germany.* **O. Thallner.** (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1690–1697, Oct. 20, 1906.)—The chemical composition and microstructure of the various German brands of such steels are dealt with. L. H. W.

167. *Cleaning of Work by Means of the Electric Current.* **H. S. Coleman.** (Faraday Soc., Trans. 2. pp. 53–54 ; Discussion, pp. 54–55, Aug., 1906. Electrician, 56. p. 1057, April 13, 1906. Chem. News, 93. p. 167, April 12, 1906.)

168. *Formula for the Period of Ionic Vibration and the Laws Resulting from it.* **G. Rosset.** (Écl. Électr. 48. pp. 84–97, July 21 ; 167–172, Aug. 4 ; and pp. 201–210, Aug. 11, 1906.)—A theoretical paper on the phenomena of electrolysis in continuation of previous work. (Ibid. 42. pp. 81–89, 128–138, 165–174, 1905, and 46. pp. 446–456, 1906.)

169. *Passive State of Metals. Reply to W. J. Müller.* **C. Fredenhagen.** (Zeitschr. Elektrochem. 12. pp. 797–798, Nov. 2, 1906. Theoret.-phys. Inst., Leipzig, Oct., 1906.)—In his study of the anodic behaviour of Zn and Mn [see Abstract No. 2305 (1905)], W. J. Müller had come to the conclusion that the passivity could not be due to the formation of an alloy, metal-oxygen or of a solution of oxygen in the metal, as assumed by the author [see Abstract No. 189 (1904)], because a definite p.d. was required for the deposition of oxygen. The author criticises the objections as being too indefinite. H. B.

170. *Electrolytic Dissociation in Relation to Refractive Index.* **J. Zoppellari.** (Gazzetta Chim. Ital. 35. 1. pp. 355–368, 1905. Zeitschr. Elektrochem. 11. p. 881, Dec. 1, 1905. Abstract.)—An investigation of the relation, confined to solutions of non-electrolytes. L. H. W.

171. *Gas-cells at High Temperatures.* **F. Haber** and **F. Fleischmann.** (Zeitschr. Anorg. Chem. 51. 2. pp. 245–288, Nov. 13, 1906.)—The full paper corresponding to Abstract No. 1489 (1906).

172. *Electrolyses in Acetone and Pyridine.* **M. G. Levi** and **M. Voghera.** (Gazzetta Chim. Ital. 35. 1. pp. 277–290, 1905. Zeitschr. Elektrochem. 11. p. 880, Dec. 1, 1905. Abstract.)